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22

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DEBATE OVER VACCINATIONS

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LETTER FROM THE EDITOR

Dear Readers,

In the political climate in which we live today, it sometimes feels as though science takes a back seat to controversy. A portion of our political leaders continue to deny the existence of climate change, or laugh off the extent to which humans are able to make an impact on our planet. The spread of Ebola from Africa to the United States has tempered arguments over the proper treatment of health care workers who may be infected with the disease. Meanwhile, illnesses long thought eliminated as a threat to children, such as pertussis and measles, have resurfaced in states where parents disagree over the safety of vaccines.

Yet in looking back at how science has been received throughout the centuries, it becomes clear that science and controversy have always been linked. It is in the nature of new discoveries to challenge that which we know about the world-- to break down our ideas of what is safe, what is normal, and what is sure. In doing so, controversy can actually serve as a tool to shape novel ideas and inspire new research. Without a healthy debate, science might not be as fascinating and multi-faceted as it is today.

This issue of NUSci is dedicated to the issues that start conversations, foster disagreements, and even fire up tempers. In these pages, our writers attempt to lay out the debate behind some of the most pressing questions challenging scientific minds today: Should humans attempt to colonize Mars? Is it right to use animals for medical testing? What will our nations do with refugees displaced by the sea level rise? Should we use our godlike ability to clone cells to bring back extinct animals, returning woolly mammoths, Tasmanian tigers, and dodos to the earth?

We won't pretend we have all of the answers to these questions. In fact, history shows that even when an issue appears to be closed or a question answered, there is always a new discovery lurking around the corner to once again shatter our perceptions. Our feature story takes us through some of these earth-shaking discoveries from the past 200 years, each of which flipped public and scientific perception of how our world works--sometimes with dangerous results.

As always, our writers, editors, and designers were invaluable in the creation of Issue 22. We thank them profusely for the hard work and long hours that went into bringing you this issue, particularly given the short turnaround we asked of everyone.

This issue is also the last this year for which Katie and I will be acting as co-editor-in-chiefs. Next semester, we will each be moving on to new horizons--Katie to Panama and Washington with the Three Seas Program, and I to New Zealand on SEA Semester. While we could not be more excited for our upcoming adventures, we will also be sad to say goodbye to our NUSci family for a little while. For me, this goodbye is particularly difficult, as I will be graduating in May and leaving the magazine in the capable hands of our upcoming editorial staff. I cannot thank everyone at NUSci enough for the fun and challenging experiences the club has provided over the past three and a half years, and know that this magazine has made me the writer I am today.

We hope that you enjoy the 22nd issue of NUSci. If the issues in these pages make you angry or speak to your passions, I encourage you to investigate them further. Even if just in a debate at the dinner table, robust discussion of these issues is what fosters innovation. You never know what you may come up with--remember, Galileo, Darwin, and Einstein were all once young men with crazy ideas.

Claudia Geib
Journalism and Environmental Science, 2015
Co-editor in Chief

Cover images courtesy of Steve Jurvetson on Flickr, and wikipedia

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MEDICATING NORMAL?

The DSM-V

BY NAOMI STAPLETON, PSYCHOLOGY, 2016

The Diagnostic Statistical Manual of Mental Disorders (DSM)'s most recent and controversial iteration may no longer be hailed as the "Psychiatrist's Bible." Released in May 2013, this new version has been heavily criticized for "hypermedicalizing" mental illness, perhaps stemming from excessive pharmaceutical industry influence and an insider editing approach.

Heated debate is by no means a new thing for mental health professionals; the DSM's sixty-year evolution has been plagued with controversy and what some describe as "fad diagnoses." For example, early editions diagnosed homosexuality as a sociopathic personality disorder and autism as childhood schizophrenia. Now hypothetically armed with a more refined and evidence-based understanding of mental illness, the fifth edition consists of 947 pages classifying nearly 300 disorders. A 28-member DSM taskforce was formed in 2007, when the American Psychological Association (APA) announced a lofty goal of a "paradigm shift" in mental health diagnoses. Since then, there has been far more academic arguing than paradigm shifting. In fact, the new edition's changes triggered significant backlash in the psychological community.

Missed deadlines, cancelled field testing steps and general disorganization surrounding the revision of the DSM-V led to what critics describe as a rushed and botched final edition. The taskforce also allegedly refused to acknowledge input from the wider mental health community. Despite widespread concern regarding many of the suggested changes, the APA rejected a petition by more than 50 mental health associations calling for an outside review.

This outright rejection of outside input was particularly worrying based on the considerable pharmaceutical industry influence within the taskforce itself. A 2011 report by The Psychiatric Times found that only eight of the 27 member group reported no industry relationships, an almost 14 percent increase in pharmaceutical influence from the taskforce for the DSM-IV. Diagnosis of a disorder dictates prescription, and with the DSM serving as an almost universal

psychological standard for mental health diagnosis, pharmaceutical companies clearly have a vested interest in the structure of the DSM. The taskforce responded to the accusations by saying that collaboration between their researchers and the pharmaceutical industry is "vital to the current and future development of pharmacological treatments for mental disorders."

Citing the APA's pharmaceutical financial interests, many condemn this DSM's "hypermedicalization" of mental illness. Mental health professionals worry that by lowering many disorders' diagnostic thresholds, the new edition unnecessarily introduces a whole new population to the world of psychiatric medicine. Lucy Johnstone, a clinical psychologist, described this as the "medicalization of everyday life."

"THE DSM'S SIXTY-YEAR EVOLUTION HAS BEEN PLAGUED WITH WHAT SOME DESCRIBE AS 'FAD DIAGNOSES'."

For example, General Anxiety Disorder (GAD) still includes classic symptoms like restlessness, a sense of dread, and feeling constantly on edge, but the new edition only requires the patient to have at least one of these symptoms for a month, rather than three symptoms for three months. Critics suggest these changes blur an already vague disorder definition, facilitating the medication of everyday worries.

Another major cause of controversy involved Major Depressive Disorder (MDD). In previous editions the criteria included a grief exclusion clause: bereavement within two months disqualified patients from a diagnosis of depression. The DSM-V famously removed this stipulation; critics suggest that as a result society will begin to medicate grief, a healthy and human process. However, the APA argues that the exclusion clause incorrectly implies that

grief only lasts two months. They also accurately suggest that bereavement is a significant psychological stressor that could precipitate a major episode in an already vulnerable patient. In older editions with the bereavement clause, such patients would not be able to access their medication through insurance.

In actual fact, very little data concerning the prevalence of these controversial disorders have been published since the new edition was released. The few relevant studies did note slight changes in diagnosis for some patients, but not anything so dramatic as no longer diagnosing any mental disorder. For example, critics worried that the merge of "Autism Spectrum Disorders" would limit many children's ability to be diagnosed and treated. A study by Autism Speaks found that 83 percent of children diagnosed with Autism under the DSM-IV would still receive that diagnosis under the newest edition. The majority of the other 17% would be diagnosed with Social Communication Disorder, and thus would still have access to any necessary treatment.

Perhaps such findings suggest that these allegedly "hypermedicating" revisions have not been as impactful as predicted. The controversy surrounding the DSM-V is clearly not unfounded, and academic debate is essential to continue enhancing our understanding of mental health. However, the DSM-V is not the final word in diagnosis: the major decisions still remain with trained professionals who personally interact with their patients, as it should be. The DSM should be seen as a diagnostic tool that supports clinicians and psychiatrists in their efforts to ensure access to medication for those that need it. Unfortunately, our healthcare system requires that the DSM draw some sort of diagnostic line in order to prescribe. By lowering diagnostic criteria, this new edition means that patients who are clearly mentally ill, yet do not necessarily fit a precise definition of a disorder are still able to access the medicine they need to be well. Critics focus too much on potential abuse of the system, rather than supporting those who truly depend upon the system to survive. ■

A D H D

Hyperactive or Overdiagnosed?

BY JESS MCINTIRE, BEHAVIORAL NEUROSCIENCE, 2015

It is not uncommon to meet someone diagnosed with Attention Deficit Hyperactive Disorder (ADHD), which affects 3-7 percent of schoolchildren in the U.S. However, it is just as common to meet someone that believes there are serious problems with the way the disorder is diagnosed.

The popular opinion says that ADHD is diagnosed too often or that it is not a legitimate condition at all. A survey performed by CNN in 2002 found that 76 percent of respondents believe that the disorder is over-diagnosed. In 2004, Dr. Phil hosted a segment titled "Parenting with Pills," criticizing medication as a method for dealing with the behavioral problems associated with ADHD. Roger Bullock from the Warren House Center for Social Policy describes that people tend to see it as "an invention designed to mask a mixture of deprivation in emotional areas compounded by over-indulgence in others and the failings of exhausted parents struggling to carve out quality time with their offspring." His description seems to ring true. Medication is often touted as an easy answer for behavioral problems, allowing parents to shirk some of their responsibility.

Psychology

How did the public develop such an unfavorable opinion of ADHD? A review study by Mark Scitutto and Miriam Eisenberg from Muhlenberg College proposes that it is a result of psychological principles rather than a careful interpretation of data. Most people get their information from personal experience or the media rather than from professional literature, leading to bias. The media selects the most compelling and dramatic stories in order to attract an audience, even if they are not representative of the truth. Inappropriate diagnoses of ADHD also tend to be memorable, in part due to stigmas about the psychotropic medications used to treat ADHD. These drugs are nearly chemically identical to illicit drugs such as methamphetamine, which evokes concern, especially when they are administered in children who do not need them. False negatives, cases in which children who

have ADHD are not diagnosed, are more likely to go unnoticed, but can be seriously harmful. ADHD patients not diagnosed until adulthood who do not receive treatment demonstrate debilitating deficits in social, academic, and workplace environments.

Simply put, for ADHD to be considered overdiagnosed, the cases of false positives must outnumber the cases of false negatives, and there is simply not enough data to provide a concrete answer. Variability in assessment procedures performed by clinicians contributes to the number of false positive diagnoses. While the criteria for an ADHD diagnosis is clearly described by the Diagnostic and Statistical Manual of Mental Disorders, a study performed by Katrin Brochmuller and colleagues at the University of Basel found convincing evidence that in many cases, clinicians do not adhere to the criteria. The group sent out fake patient files to approximately 500 clinicians and asked that they diagnose the patient as if it were a factual case. One case met all requirements for a diagnosis of ADHD, while three others fit only some of the criteria and so were ineligible for diagnosis. The responses showed false-positive diagnoses at a rate of 16.7 percent, indicating that clinicians sometimes diagnose ADHD in inappropriate cases.

Symptoms

The study also suggested that women might be under-diagnosed. Cases sent out with a boy's name were falsely diagnosed twice as often as files with a girl's name. Girls present the symptoms of ADHD differently than boys, and also differently from the common stereotype. Instead of primarily hyperactive symptoms, which tend to produce disruptive behavior, girls are more affected by symptoms of inattention that are less easily detected.

While results are inconclusive on whether ADHD is overdiagnosed, diagnostic methods could certainly be improved. Currently, the diagnostic criteria are a set of six symptoms of inattention and six symptoms of hyperactivity

rated by a clinician, an inherently subjective process. In fact, it was shown that depressed mothers have more negative perceptions of their children and are therefore more likely to focus on bad behaviors when discussing their child with a clinician.

Diagnosis

Biomarkers are the best chance for making objective diagnoses with the lowest error rates. The FDA describes a biomarker as "an objective measure of normal, pathological, or pharmacological processes," and there are biological differences in ADHD that can be assessed. For instance, evidence has been presented indicating morphological differences in multiple brain regions, including the thalamus, which processes sensory information.

Dr. Heather Brenhouse, a Clinical Neuroscience professor at Northeastern, says that "effective diagnosis and treatment of ADHD will require biologically-targeted criteria, in order to cut through the challenges of parsing individual differences and the influences of media and stigma." As an example, she cites an innovative lab at McLean Hospital in Belmont that has created an effective method of quantifying ADHD behavior by measuring involuntary head movements while patients are performing an attention task. Other possibilities include factors related to dopamine and norepinephrine, chemicals in the brain targeted by currently used ADHD medications. Dr. Brenhouse feels that "these discrete and simple kinds of measurements will continue to improve our ability on a large scale to hone in on what is ADHD, and what is not."

As in the case of many psychological disorders, our understanding of ADHD, including how we diagnose it, is far from perfect. With additional research efforts focused on identifying biological changes associated with the disease, clinicians are on their way to achieving perfect diagnosis. ■

A large pile of red and yellow apples is shown on the left side of the image, resting on a dark wooden surface. The apples are of various shades of red and yellow, with some showing green. The wooden surface has a prominent grain pattern.

GETTING TO THE FRUIT OF CORE AND STEM

BY EMILY ASHBOLT, BIOMEDICAL PHYSICS, 2017

The Common Core, a nationwide set of education standards for mathematics and language arts in grades K-12, is a hot-button issue from every side of the political spectrum. Supporters claim that it creates a forward-driven unity in American education that can help students achieve, both in K-12 and beyond. On the other hand, critics claim it does not work, and both alienates teachers from their subjects and students from cohesive knowledge. In its implementation, the core's purpose was said to "provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them." It is not a government-issued curriculum, as some might think, but a list of guidelines for Mathematics and English and Language Arts (ELA), which all students should meet by the end of each school year.

To measure each student's grasp of the core subjects, standardized tests are required. These standards were devised by a team of teachers and experts, based on field studies and school data, and are intended to be "robust and relevant to the real world," focusing heavily on concepts and problem-solving tools. The whole initiative is sponsored by the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO), and was fully supported by President Obama in an effort to make sure that more American students are entering two-year, four-year, or vocational programs with the kind of credentials and knowledge base that is generally required nationwide.

The issue that arises for some schools about this program is that it is not, as previously stated, a curriculum, but only a set of guidelines, requiring support both within its own standards and from the school in a broader scope. Students, finding their arts and humanities courses cut to make more time for core standards preparation, or discovering that it is harder to take courses higher than the core-standard level due to increased duties placed on their educators, can have a less than rosy view of the common core standards.

There is no denying, however, that the education system in the United States needs some work. "Forty-three states, the District of Columbia, four territories, and the Department of Defense Education Activity (DoDEA)" have voluntarily adopted the core in hopes it will improve the system.

Yet as of June 18, 2014, four states have repealed or are withdrawing from the Common Core. Nine additional member states have begun to develop legislation that would repeal mandatory Common Core participation, known as House Bill 597. This bill puts state leaders back in charge of creating education standards for each state.

The difficulty is that not all states have the same standards. The Center for American Progress and American Association of University Women recently released a fact sheet of all the reasons why common core will benefit the US. Actual analysis of what the core has been able to achieve since its initial adoption in 2010 is set to take place at the end of the 2014-2015 school year. However, this fact sheet only aims to outline the kinds of things a common core could achieve—ensuring that all kids are leaving school on a much more level playing field. By evening out the baseline, the Center for American Progress argues that that more students will be more willing and able to take their education further.

"High expectations and rigorous standards—including those embodied by the Common Core—are essential to raising student achievement. Success in STEM fields is crucial not only for students themselves, but for our national economic outlook," said Carmel Martin, Executive Vice President for Policy at CAP.

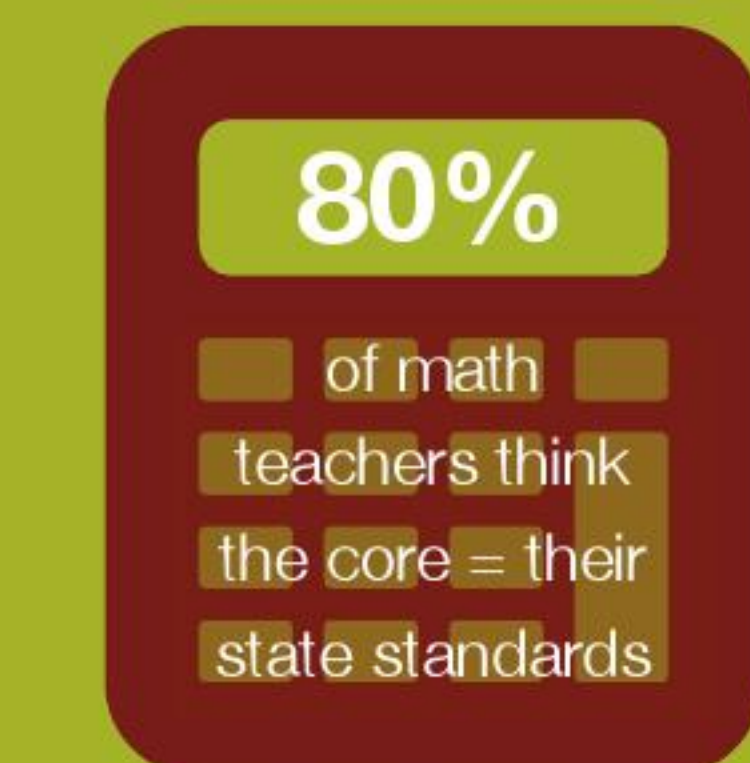
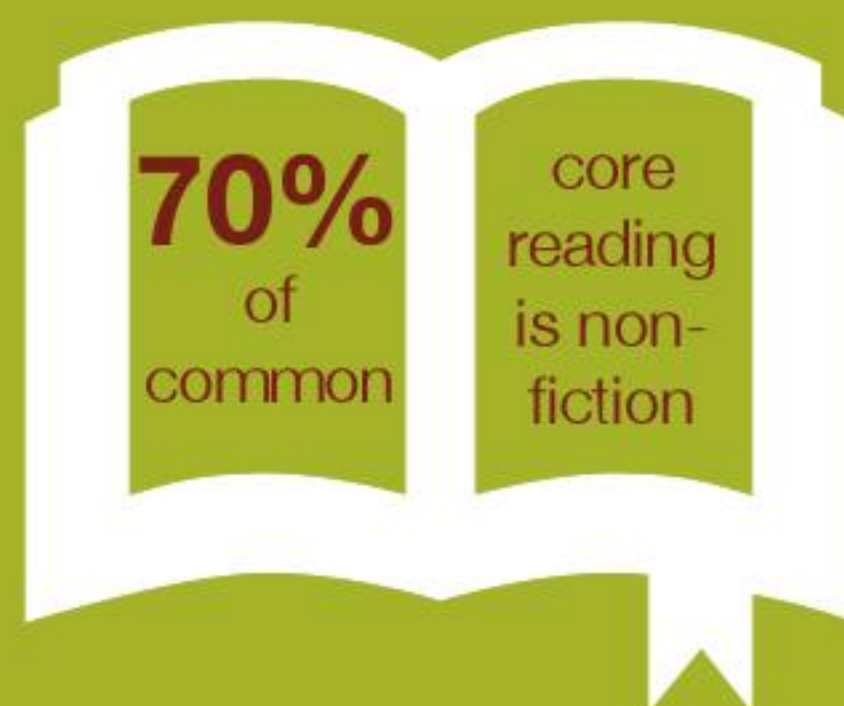
Lisa Maatz, AAUW Vice President of Government Relations, claims her research "has found that one way to mitigate stereotypes' damaging effects is through explicit and transparent standards, such as the Common Core... [which] ensures that all students are being taught the standards they need to succeed."

This is a summary banner quote for the pro-core movement, which hopes that in equaling education, they can counteract the bias that might prevent girls and minorities from pursuing much-needed STEM jobs.

While higher education standards are often difficult to criticize, the question remains whether they will lead to any kind of increase in STEM achievement. For example, the core's two main focuses are math and English language arts, excluding science, engineering, and computer science, the latter of which is almost universally agreed by professionals to be one of the most important skills for today's world. The math common core standards stop before pre-calculus. Plus, government data has shown that only 2 percent of STEM majors who enter an undergraduate program at a pre-calculus level (or lower) will get their degree.

Alone, however, the core is simply not enough to propel anyone to more STEM success. For schools that are already struggling with budget, enacting a new educational system can leave few corners unscathed. Even mathematician Jason Zimba, who actually assisted in writing the math section of the core, has admitted, "If you want to take calculus your freshman year in college, you will need to take more mathematics than is in the Common Core."

The common core is a step in the right direction to improve student output in K-12. But as unwise as it would be to shut this new system down without knowing anything about its results, it would be equally as foolish to place too many expectations on it as a method to revolutionize American progress into secondary education and beyond. ■



STATISTICS FROM NATIONAL REVIEW ONLINE



FEAR, FURY, AND FIDO:

A LOOK AT THE ANIMAL RIGHTS DEBATE IN RESEARCH

BY RACHEL STODDARD, BIOLOGY, 2017

If you Google “animal rights,” you will get about 12 million hits. To put this into perspective, these results fall somewhere in between the number of hits for Emma Watson and Ebola. The sheer magnitude of information on the animal rights debate is staggering. Contrary to their cuddly mascots, the animal rights movement has brought out an exceptional amount of extremism throughout the years, including images of red paint dumped on fur coats, threats to researchers, and support of taking illegal action from some of the most renowned animal rights groups. The debate on animal rights has become so prevalent and polarized in the U.S. that it is estimated that over \$100 million in damage has been done in the past two decades in the fight for animal rights.

At the forefront of this debate is the issue of animal testing, and whether the practice of using animals in the laboratory is ethical. While it is easy to say that Fido should not suffer in the name of the perfect shade of lipstick, the ethics become less clear when discussing biomedical research. Animal rights organizations, such as the People for the Ethical Treatment of Animals (PETA) and the Animal Liberation Front (ALF), champion the idea that animals have the right to live free of suffering and exploitation at the hands of human beings. According to PETA's website, “there are some medical problems that can probably only be cured by testing on unwilling people, but we don't do it because we recognize that it would be wrong...we need to extend this same concern to other living, feeling beings, regardless of what species they may be.” Animal rights activists argue that if human beings would not consent to the experiments done on these animals, they should not be performed at all.

These arguments gain traction from a few, very highly publicized, horror stories of animal cruelty at the hands of medical researchers. One such study was conducted at Ohio State University to examine the effects of methamphetamine on

the progression of the AIDS virus through the system. This study, which involved infecting cats with a close cousin of the AIDS virus and then injecting them with crystal meth, caused the lead researcher to lose his job and relocate his family due to the extreme backlash from animal rights activists.

These horror stories involving beloved domestic animals are not the norm: Dogs and cats make up less than one half of 1 percent of the laboratory animals used in the U.S. for research, according to the National Association for Biomedical Research. Over 95 percent of laboratory animals are rats and mice, species which face death everyday at the hands of humans, completely unrelated to the scientific community. Advances in medicine, afforded by animal testing, have touched every human life. Research on cows has been credited as a key component of the development of the smallpox vaccine, eradicating “one of the world's most devastating diseases” according to the World Health Organization. Testing on rats and monkeys is also responsible for the discovery of the polio vaccine, another disease that devastated the early part of the 20th century before the invention of the life-saving vaccine.

“OVER 100 MILLION DOLLARS OF DAMAGE HAVE BEEN DONE IN THE PAST TWO DECADES IN THE FIGHT FOR ANIMAL RIGHTS”

In a 2011 poll done by *Nature*, nearly 90 percent of biomedical scientists agreed that animal testing is necessary within their field. Over 70 percent of the scientists were uncomfortable about voicing their opinions on the issues surrounding animal testing because of the “highly polarized nature” of the debate. The

imagery surrounding the animal rights debate and the “good versus evil” rhetoric of animal rights activists has made many in the scientific community feel as though they cannot comment on these issues for fear of backlash from the animal rights movement.

In an attempt for middle ground in this debate, many organizations take the stance of promoting animal welfare over animal rights. Animal welfare is a more ambiguous concept, essentially endorsing the idea that animals shouldn't be treated with cruelty or forced to undergo any unnecessary pain and suffering. Many activists take issue with this “soft” wording, saying that the definition allows animals humane treatment only so long as that does not get in the way of their own purposes. Indeed, the Animal Welfare Act of 1966 excludes animals bred for research, because of the necessity of the laboratory work. National Institutes of Health (NIH) funded research involving animal testing is subject to recommendations, rather than regulations, and heavily reliant on self-reporting. There has also been a push since the '90s to help researchers reduce, refine, and replace methods of animal testing to make laboratories more humane. At the end of the day, however, researchers still have an exceptional amount of free reign in their practice of animal testing.

There are no easy answers in this debate, and it is certain to continue on for many years to come. One thing that is clear, however, is that more nuanced perspectives need to be given an equal chance at the table. There must be a perspective which allows for both the recognition of the need for regulation on the humane treatment of animals and recognition of the importance of animal testing in biomedical spheres without scientists fearing vandalism or death threats from animal rights activists. ■

MENTAL GPS SYSTEM WINS NOBEL PRIZE

BY JORDYN HANOVER, BEHAVIORAL NEUROSCIENCE, 2017

In 1971, John O'Keefe published a paper that suggested that spatial memory is stored in the hippocampus, an area of the brain that is directly involved in the formation and consolidation of long term memories. O'Keefe went on to determine that within the hippocampus, there are specific "place" units (cells) that give the animal the ability to build mental maps of the space in which they are moving. Over thirty years later, Edvard and May-Britt Moser discovered that different spatial memory circuits involving these place cells are related to the entorhinal cortex, an area directly adjacent to the hippocampus. In 2014, all three scientists were jointly awarded the Nobel Prize in Physiology or Medicine "for their discoveries of cells that constitute a positioning system in the brain."

Initially, O'Keefe noted that cells in the hippocampus of a rat would fire when the rat was stationed in specific areas of the given environment. The term 'place field' was defined as the region of the brain within which the cells fire greatest. He studied the orientation of place fields within controlled environments and the effects of hippocampal place units. When sections of the hippocampus were removed, the rats being tested displayed navigation problems. O'Keefe continued to study the place cells within the hippocampus, and determined that these cells activated in specific locations, determined position, and were involved in spatial memory encoding.

In the early 2000's, Edvard and May-Britt Moser noted that specific cells, called grid cells, in the entorhinal cortex would fire when rats moved through certain locations. They also noticed that border cells, a fairly uncommon cell type, could geometrically direct grid and place fields. They concluded that these cells formed specific spatial patterns, often in the form of a hexagonal grid, as the rat passed through various positions. The grids themselves have several important attributes that the cells use to map directly onto the entorhinal cortex: the spacing between fields, and, relative to external references, orientation and phase (or tilt and displacement). These aspects of spatial awareness are thought to be similar in humans.

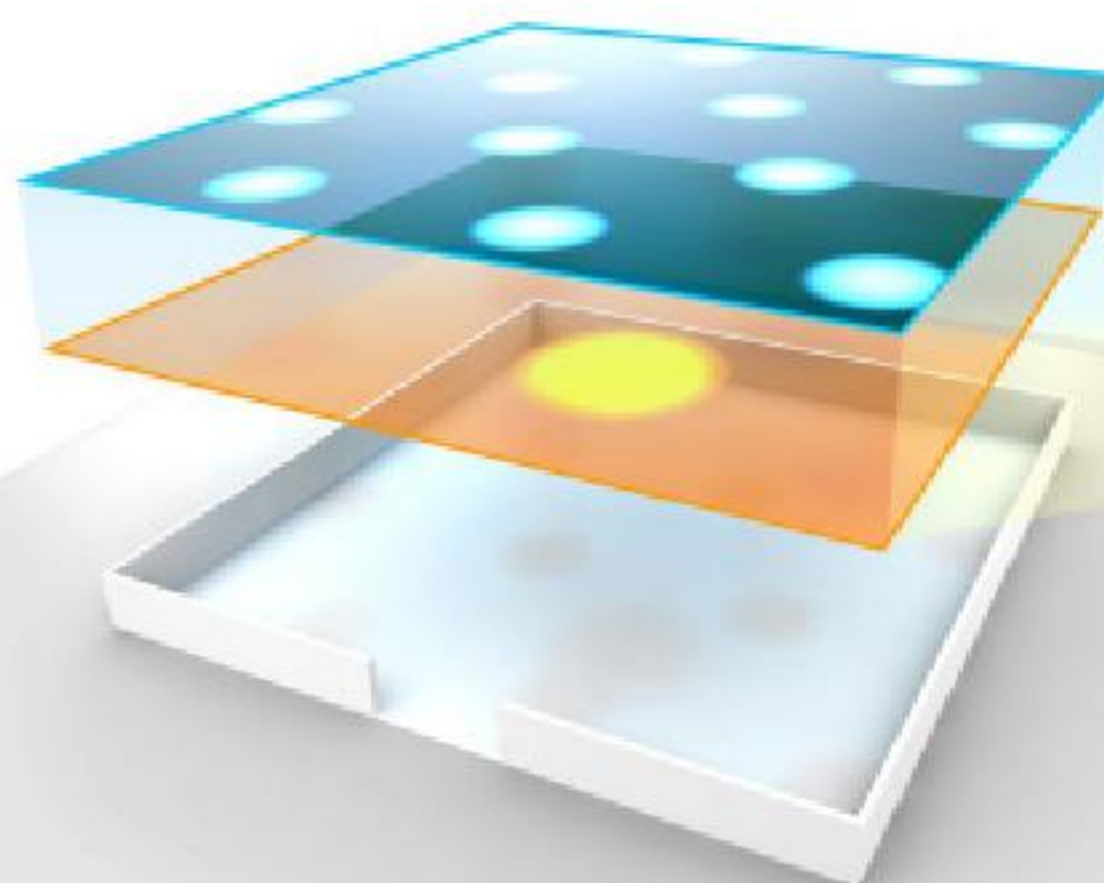
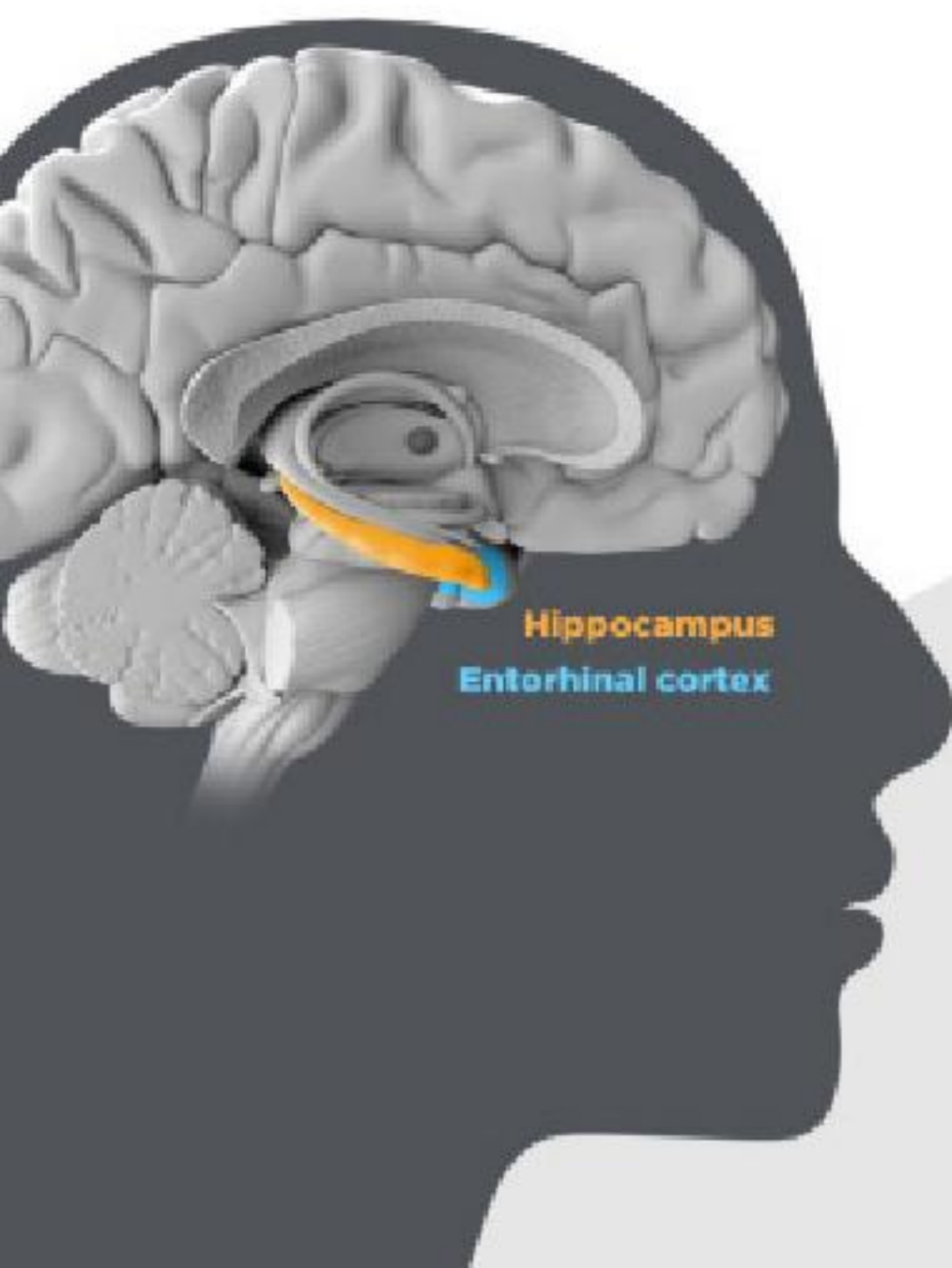
"GRID CELLS AND PLACE CELLS OFFER ONE OF THE FEW BRIDGES NEUROSCIENTISTS HAVE LINKING THE CELLULAR LEVEL TO THE COGNITIVE LEVEL."

According to a 2008 paper published by Emilio Kropff and the Mosers in The Annual Review of Neuroscience, the interactions of place and grid cells are thought to "form the basis for quantitative spatiotemporal representation of places, routes and associated

experiences during behavior and in memory." Both place and grid cells rely on external cues and geometric boundaries to determine where a cell will fire, and the fields of place cells can be determined based on where certain populations of grid cells fire. At the conclusion of the review, the authors determined that with further studies of the interactions between grid cells and place cell, the mechanisms and significance of the overall spatial navigation system could be fully understood, a novel concept for a non-sensory area of the brain, since this understanding has never been achieved outside the basic five senses.

The Nobel prize-winning combination of place and grid cells have been described as essentially a "GPS system," because the two interact to determine spatial navigation – the brain's version of GPS coordinates. In an October 6 press release, the director of spatial cognition at the University College of London, Hugo Spiers, succinctly summed up the importance of the discovery: "Grid cells and place cells offer one of the few bridges neuroscientists have linking the cellular level to the cognitive level, as they help explain how individual brain cells help us navigate, remember the past and imagine the future." The ability to link the cellular and cognitive processes will lead to a more comprehensive understanding of the brain's inner workings, and how we translate our brain signals into actions. ■

Image courtesy of extremetech.com





Recreating Deadly Viruses?

BY MEGAN PINAIRE, MARINE BIOLOGY, 2017

Photo courtesy of Xavier Donat on Flickr

The Spanish Influenza of 1918 was the deadliest pandemic in modern history. The lethal virus, now thought to have come from a mutation of wild bird flu, infected 20 to 40 percent of the world's population and killed 50 million people worldwide. The virus touched all corners of the globe, including populations on remote islands, main continents, and the Arctic. What made this pandemic so dangerous were both the high infection rate and the severity of the symptoms. People who felt healthy in the morning could be dead by bedtime. The most bizarre part of the virus was the fatality patterns: those infected and dying at the highest rate were healthy adults. Normally flu viruses are most deadly for weaker age groups, such as children and the elderly. Why the Spanish Influenza was different from other flus is still unknown.

This flu virus caused more deaths than World War I. Today, a group of scientists are trying to bring it back.

Lately, there have been a series of highly debated studies where groups of scientists create dangerous viruses in the lab in order to find out how existing strains of a virus could mutate and adapt to infect humans in the future. Critics condemn these studies, arguing that the work is not directly saving lives and is therefore not worth the risk of accidentally spreading the dangerous viruses.

A group of scientists led by Yoshihiro Kawaoka from the University of Wisconsin are conducting the latest of these controversial studies. They built a virus that is only three percent different from the incredibly deadly 1918 influenza virus, combining multiple wild bird flu strains into one strain and mutating it to make it airborne, giving it the ability to spread through the air. Preliminary mutations were less harmful than the Spanish Influenza when tested on rodents. However, the scientists persisted in their project, and a

number of mutations later, they created a more dangerous strain that spreads the same way as human flu viruses – through water droplets.

While the scientists have been labeled "crazy" by their critics, Kawaoka says that the study is meant to demonstrate how wild bird flu strains have the potential to mutate into human flu strains and cause a pandemic similar to that of 1918. The researchers claim the swine flu vaccine from 2009 should be effective on this new strain they created. Kawaoka and his colleagues assert that their work benefits public health, but with the chance that the recreated virus could be exposed to the public, opponents dispute this claim.

A mutation in the DNA is random, unpredictable and never intentional. The chance of the exact strain the scientists created appearing in nature through mutations in wild bird populations is so slim, and the risk of this treacherous synthesized virus infiltrating society is so dangerous compared to the possible benefits to public health. Harvard School of Public Health professor Marc Lipsitch agrees, saying that "this is a risky business...scientists should not take such risks without strong evidence that the work could save lives, which this paper does not provide."

With the extensive effort the United States is taking to keep the Ebola virus out of the country, it is surprising that the National Institutes of Health are funding such a project. A nurse who recently returned from West Africa was quarantined as soon as she stepped off the plane because New Jersey Governor Chris Christie suspected that she was ill with Ebola. She was kept in isolation until she was deemed symptomless for 24 hours.

These measures were taken over a possible case of Ebola, a rare and not easily transmitted virus, entering the country. At the same time, the

easily transmitted and widely lethal 1918 flu virus that devastated the globe is being intentionally regenerated in the country. Perhaps the media coverage of the gruesome effects of Ebola has made Americans hyperaware of this rare virus, despite the realistically extremely slim chance of an outbreak. Meanwhile, no modern media has covered the Spanish Flu, and thus the general public has no fear of it.

The swine flu outbreak of 2009 that killed 500,000 people is still fresh in the minds of Americans. Despite this, the same man who recreated Spanish flu, Yoshihiro Kawaoka, has continued his controversial work by also recreating far more dangerous version of the swine flu, technically known as H1N1, strain. This strain would be even more devastating if it somehow escaped the "secure" lab, as H1N1 is resistant to human antibodies. That means that a vaccine cannot stop this strain. If it gets out, the human race will be completely defenseless. Since H1N1 is transmitted like any other flu virus and is therefore fairly contagious, an outbreak would likely be rapid and widespread.

Kawaoka's goal is to perfect future flu vaccines, and he claims that creating these resistant strains will help him reach this goal. Even in the face of criticism, Kawaoka continues to defend his work, insisting on its "life-saving benefits."

In the end, this research is being conducted under appropriate biosafety procedures, according to the National Institutes of Health, in order to better understand the deadly impact of the 1918 flu virus. It has been determined by those funding the project that the information gained has the potential to help public health officials understand the circulation of pathogens. ■

VACCINES:

an epidemic of misinformation

BY KRISTEN DRUMMEY, BEHAVIORAL NEUROSCIENCE, 2017

In recent years, vaccines have seemed to go from health saviors to entities of evil in the realm of public opinion. "Balanced" media coverage and vehement anti-vaxxer advocates continue to spread dangerous misinformation about the safety and efficacy of vaccines, in direct opposition to countless scientific studies saying the opposite. For people familiar with the scientific community, the conclusion is obvious: vaccines are safe, and have kept us healthy for decades. But to concerned parents, the conclusion isn't as clear. Although links between autism and vaccines have been debunked in the scientific community, perpetual misinformation is legitimately concerning to parents, especially those who are struggling to raise an autistic child.

Nicholas was diagnosed with autism when he was 2 ½ years old. His mother Leann noticed that he wasn't progressing normally, and received the crushing diagnosis in March 2005. A few years later, his younger brother Michael was born. As Leann says, "I was super nervous for him to have the MMR vaccine. He should have gotten it at 18 months, but I waited until he was two years old. He got it, and I watched him like a hawk for a couple of months," looking for signs of regression. Michael is now a vibrant six-year-old, with no signs of regression. Although Leann does not believe that vaccines contributed to Nicholas' autism, her hesitation as a concerned parent remained.

The inception of the supposed autism-vaccine link came in a paper published in 1998 by Andrew Wakefield, a British researcher. In the paper, Wakefield proposed that the MMR vaccine, used to inoculate individuals against measles, mumps, and rubella, was directly associated with increased cases of autism. The research launched a public panic, as concerned parents began to question whether their children's routine vaccinations could cause them to regress developmentally.

After Wakefield's study was published, further studies by a wide range of scientists were conducted in an attempt to replicate his findings. None of them were able to. On the surface, Wakefield's study was poorly conducted - he used an extremely small sample size, had no control group, and based many of his findings on parental recall instead of more solid biological measures. Upon deeper inspection,

his study held up even less. Brian Deer, an investigative journalist, found that Wakefield's paper was a complete and total fraud. Wakefield blatantly fabricated patient data to support his hypothesis that the MMR vaccine contributed to developmental problems in children, possibly to help his attempt to win his lawsuit against a company that manufactured the vaccine.

Wakefield's paper has since been retracted, and his credibility is nonexistent. In addition, numerous other studies by reputable associations, like the Center for Disease Control, have been unable to find any kind of association between autism and vaccination. However, public opinions on the matter seemed to have changed very little. This may be partly due to anti-vaccine advocates.

The Internet has become a font of conflicting information, and has given a platform for so-called "anti-vaxxers," or people who advocate against modern vaccines. Many anti-vaxxers argue that we no longer need to vaccinate, because the society we live in is essentially devoid of the illnesses that we vaccinate against. However, what they fail to recognize is that we live in such a healthy society because we have been vaccinating for so long. Vaccines have helped us to nearly eradicate many diseases that have historically plagued us, such as polio, smallpox, and measles. Although these diseases are scarce in the U.S. today, they are still prevalent in other parts of the world, where vaccines are less accessible. Unfortunately, some of these preventable diseases are starting to make a comeback. In recent years, California has been hit hard with epidemic levels of pertussis, more commonly known as whooping cough. A study published in 2013 by Jessica Atwell and her colleagues found that cases of whooping cough increased in areas where a significant number of children had a non-medical exemption from vaccinations.

Routine vaccinations are so important because they create what is called herd immunity. When enough people are vaccinated, those who are unable to be vaccinated, be that due to pre-existing conditions or legitimate religious beliefs, are still protected from the disease, because those around them are immune. However, there is a delicate threshold for herd immunity, and it seems that it is starting to unravel in some

places, like these wealthy pockets of California, where parents are opting out of getting their children vaccinated. While parents may feel that they are putting their kids' best interests first by not getting them vaccinated, they may be endangering both their children and other people around them. As Leann puts it, "a person cannot die from autism, but can die from one of the diseases we are vaccinating for."

Vaccinations are vital to maintaining the health of our society, and are non-negotiable if we wish to keep serious diseases at bay. However, media coverage and anti-vaxxer advocates continue to perpetuate dangerous misinformation about the safeness and effectiveness of vaccines. As people of science, who are certain of the validity of vaccines, it may be easy for us to brush off those who think that vaccines are dangerous. We may also fail to recognize how difficult it can be to raise a child with autism. Nicholas, now 12 years old, cannot speak, and often needs help with his motor planning, especially with new activities. However, he is fortunate enough to have a family that will do anything for him, and a mother who tirelessly works with him to improve. He is truly a beautiful child, and brings an abundance of joy and smiles to everyone he meets.

Autism is not a death sentence, but lack of vaccinations could be. Instead of dismissing parents with genuine concern and confusion over what to believe, we need to be more enthusiastic proponents of vaccines, and help to clear the haze around these scares. ■



DISCOVERY & DIVISION:

SCIENTIFIC CONTROVERSY THROUGH THE AGES

BY MATTHEW DEL MASTRO, BIOLOGY, 2017

A hush falls upon the crowd as the honorable Lord Kelvin begins to speak. The year is 1900. The prestigious lord, whose determination of absolute zero would immortalize his name as a temperature scale, prepares to address a gathering of top British physicists. With typical bravado, Kelvin proclaims, "there is nothing new to be discovered in physics now. All that remains is more and more precise measurement."

Nonetheless, in five short years, a young patent clerk by the name of Albert Einstein would publish a paper that would overturn over 200 years of Newtonian physics, throwing the field into turmoil once again. Lord Kelvin should have known better. Had he examined hundreds of years' worth of history, he would have observed a cycle of sciences continually erupting into controversy as new discoveries rock foundations once thought unshakeable. Controversy is woven within the very fabric of scientific discovery, and understanding how and why it rears its head offers vital lessons for today's researchers.

Science, a field anchored by logic, reason, and experimentation, should not be interrupted by controversy. So thought Galileo Galilei, a brilliant and affable 17th century physicist as popular at the dinner parties of the rich and powerful as he was in university lecture halls. Galileo declared, "there is no objective half-way between truth and falsehood." To such a devotee of reason, a "compelling conclusion" drawn through the scientific method would always be accepted.

As a young student, Galileo studied the scientific principles laid down centuries earlier by the Greek philosopher Aristotle. Initially, Galileo wholeheartedly accepted these principles, but his questioning nature was already raising eyebrows at the conservative universities. He found an accepting patron in the Medici family, a leading force in Italian politics. In return for their monetary support, Galileo delighted and amazed Medici guests with discoveries such as the finding that ice is denser than water and the revelation that objects in free fall accelerate at the same rate.

For all his social adeptness, Galileo's true home was behind the lens of his telescope. Galileo was one of the first to turn this groundbreaking new invention towards the heavens for scientific study. His data on planetary movements led him to an astounding conclusion: that the planets revolved around the sun, and not the earth. The idea was revolutionary. However, in Galileo's time, revolution tended to coincide with execution. Rattled by spreading Protestantism, the Catholic Church now sought to cleanse itself of corruption and heresy – by any means necessary. The Bible includes direct references to the movement of the planets around the earth, so a publication asserting otherwise was a surefire ticket to a gruesome fate.

Yet Galileo remained obstinate in his belief in human reason. He stubbornly proclaimed, "I do not believe that the same God who has endowed us with senses, reason and intellect has intended us to forgo their use. He would not require us to deny sense and reason." Galileo's publication

advocating heliocentrism was an unqualified success; it was one of the first scientific writings to be understandable and accessible to the masses. Yet the Pope was not among Galileo's satisfied readers. He had the scientist brutally tortured until Galileo, his tenacious faith in logic finally broken, renounced his heretical ideas.

Whether or not the Pope recognized the logic and validity of Galileo's arguments is irrelevant. Galileo produced a controversy because he asserted an idea conflicting with biblical teachings, which posed a threat to the power of the Church and the Pope. Then as now, science is unalterably linked with politics, and new ideas that threaten established orders are certain to incite controversy.

Galileo's findings caused controversy because they threatened to disrupt networks of political power, but his ideas also met resistance because they questioned tradition. Charles Darwin would similarly face a populace blinded to his logic by tradition. In 1825, however, his mind was occupied with other troubles. Darwin was a British medical student, but was revolted by so much as the sight of blood. He abandoned medicine, and had resigned himself to a career in the clergy when a life-changing offer allowed him to explore his true passion: natural history. Darwin was given the chance to sail around the world and observe natural phenomena, and all he had to provide in return was interesting conversation for the captain of the H.M.S. Beagle.

While aboard, Darwin was meticulous in documenting every creature, living and fossilized,

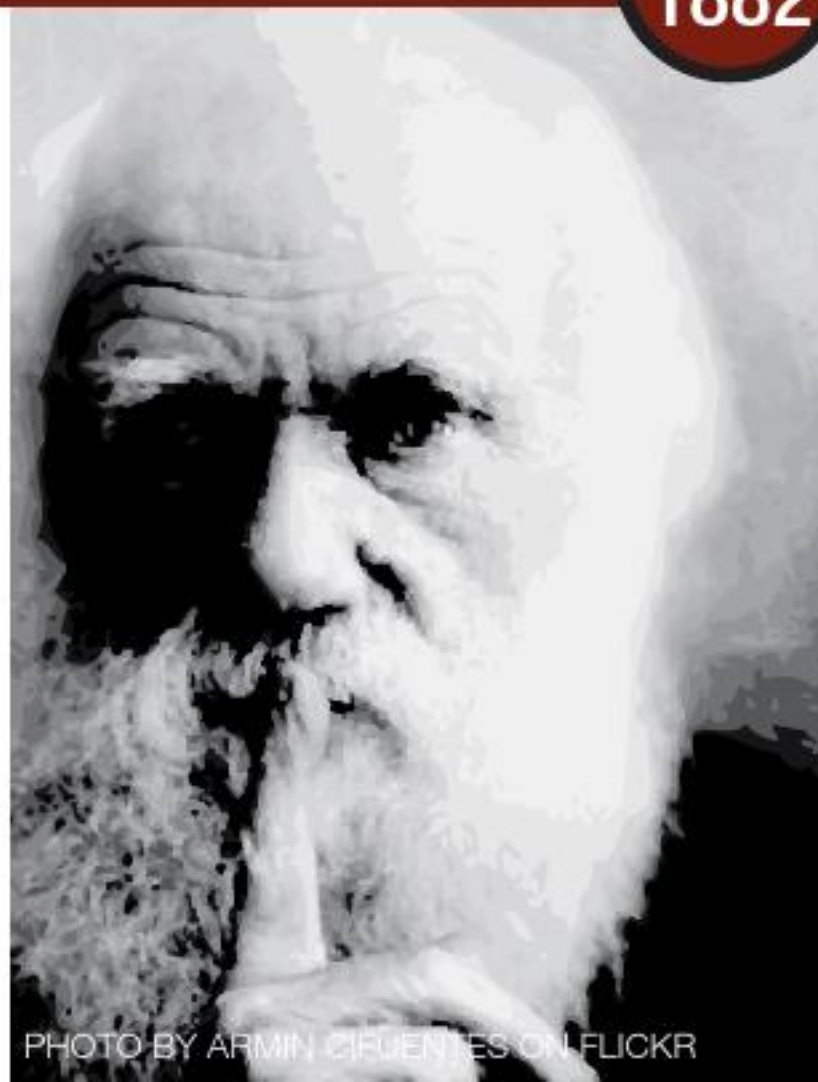
GALILEO: A VICTIM OF POLITICS

1564-1642



DARWIN: POPULAR PREJUDICE

1809-1882



NOBEL: EXPLOSIVE RECOGNITION

1833-1896



that he came across. These observations set the cogs of his mind in motion. Traditional beliefs taught that God had created each organism specifically for its particular environment, but Darwin's data showed that creatures in similar environments varied drastically. Furthermore, the fossilized creatures he found from previous eras seemed to closely resemble those currently alive in the region.

Darwin returned home to England and began to develop ideas to explain his observations. He theorized that species could vary from generation to generation, and that such variation could result in the formation of new species from existing ones. Certain organisms produced by such inherent variation would naturally be "selected" on the basis of their success in reproducing and passing on their characteristics.

His ideas solidified, Darwin's next step would be to bring them before his peers. Darwin was conscious that his questioning of traditional beliefs would not be well received by all. He likened writing his now-legendary *On the Origin of Species* to "confessing a murder." But unlike during Galileo's time, there was no political force powerful enough to suppress Darwin's controversial ideas. Darwin and his colleagues launched a fierce offensive of logic and reason. Within 20 years, characterized by tense debate, the majority of the scientific community had accepted the validity of Darwin's theory of evolution.

Still, even today, much of the public as a whole remains resistant to Darwin's new ideas regarding the progression of life on Earth. A 2014 Gallup poll revealed that 4 in 10 Americans believe that God "created humans in their present form." Even a perfectly formed logical argument cannot be accepted if the listener denies its basic assumptions, and the flames of controversy surrounding evolution will continue to burn on.

While Darwin's ideas continue to cause controversy amongst the public, another man with similar creativity and perspicacity would face a greater backlash from the scientific community itself. As symbolized by Lord Kelvin's infamous declaration, scientists of Albert Einstein's period believed they were living in an era of stability. An idea that challenged the very framework of this stability was bound to stir up controversy, but Einstein had never been one to shy from following his own path. At university, he was already more consumed with his studies of physics and philosophy than with his classes. His negligence in the classroom prevented him from progressing in academia, and the rebellious talent was forced to take a job as a patent clerk in order to support his family.

Though it can hardly have been the job that young Einstein dreamed of, the simplistic tasks of a clerk allowed him time to focus on refining his theories. At university, Einstein had already discerned that the speed of light was in fact a constant. However, such an occurrence was impossible within the context of Newtonian physics. In 1905, Einstein published his theory of special relativity, a new way to evaluate the motion of objects, in order to address this disparity. In addition to this groundbreaking theory, Einstein published an additional three revolutionary papers in the same year, including his famous equation representing the equivalence of mass and energy, $E=mc^2$.

As the world realized the importance of Einstein's discoveries the physicist was catapulted into fame. German newspapers lauded him as a hero, but within the scientific community, praise was not unanimous. Not only did Einstein's theories discredit areas of well-established classical physics, but they pushed the field towards a highly theoretical position, cordoned off to the average man. This seemed to spell an end for the "gentleman scientist" of the 19th century, who pursued science and mathematics as a leisure-time interest. Critiques

moved beyond scientific journals and began to spill over into angry lectures and brochures. The crowning moment of this rhetoric was the publication of a pamphlet titled "100 Authors Against Einstein." When queried about the attack, Einstein dryly commented, "If I were wrong, one would be enough."

The backlash Einstein felt is a reminder that scientists and their work are not immune from prejudice and personal judgments. What's more, many of the researchers that claimed to have found flaws in Einstein's proposals had in reality confused its basic tenets. When a truly revolutionary idea is released, it often takes time for the whole community to understand and accept its principles. In Einstein's case, the controversy encouraged other physicists to perform experiments to put the theory to the test, which ultimately led to its validation and general acceptance. By promoting logical and careful scrutiny of new ideas, controversy plays a vital role in science.

A study of the intertwined paths of controversy and science offers many insights for the rising researchers of today. As in Galileo's era, modern science is often inseparably linked to politics. According to a 2011 Union of Concerned Scientists (UCS) survey, 55 percent of Food and Drug Administration (FDA) scientists reported that, "FDA decisions were overly influenced by political interests." One respondent told the UCS, "Over my 40 years at FDA, science has been taking a greater and greater back seat to politics." A Public Policy Polling survey revealed that in 2013 37 percent of voters polled declared that global warming was a hoax. In such an environment, scientists must be prepared to face political controversy and stand by their results in the manner of Galileo before them. Like Darwin, modern researchers investigating high profile topics may face a public unwilling or unable to accept the implications of their results. ■

NOBEL: UNRECOGNIZED GENIUS

1856-1943

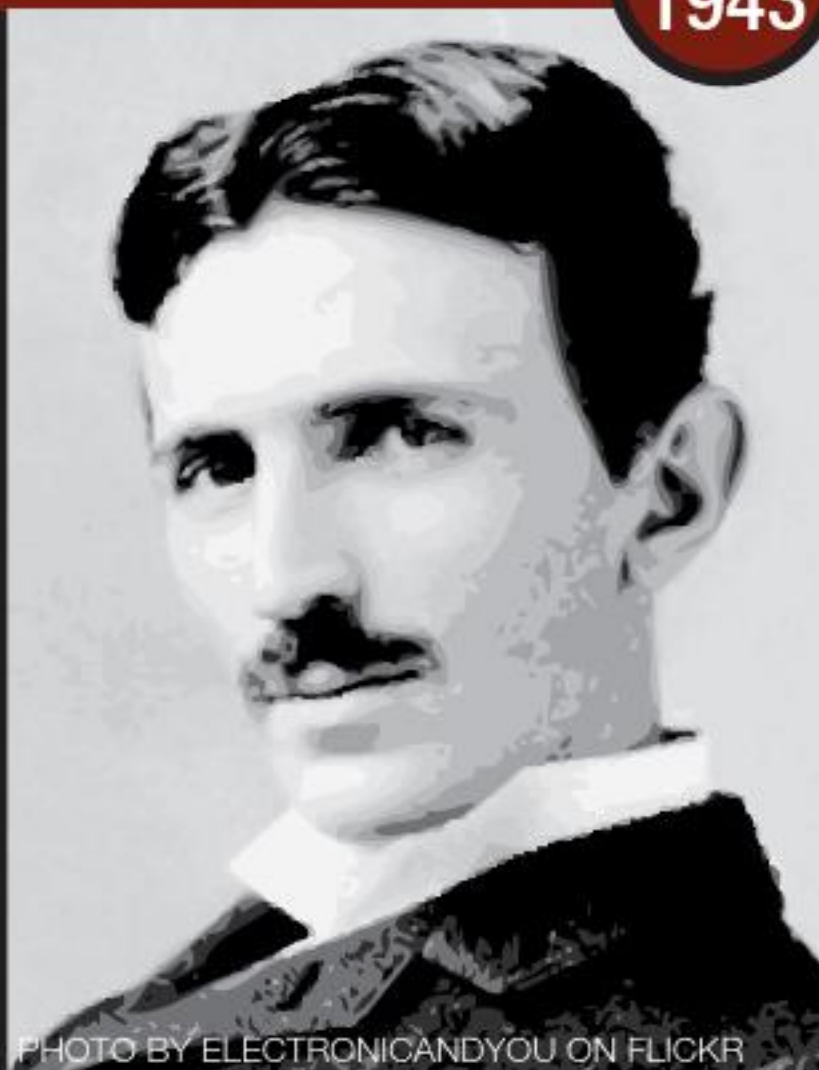


PHOTO BY ELECTRONICANDYOU ON FLICKR

FREUD: CONFLICTED FEELINGS

1856-1939

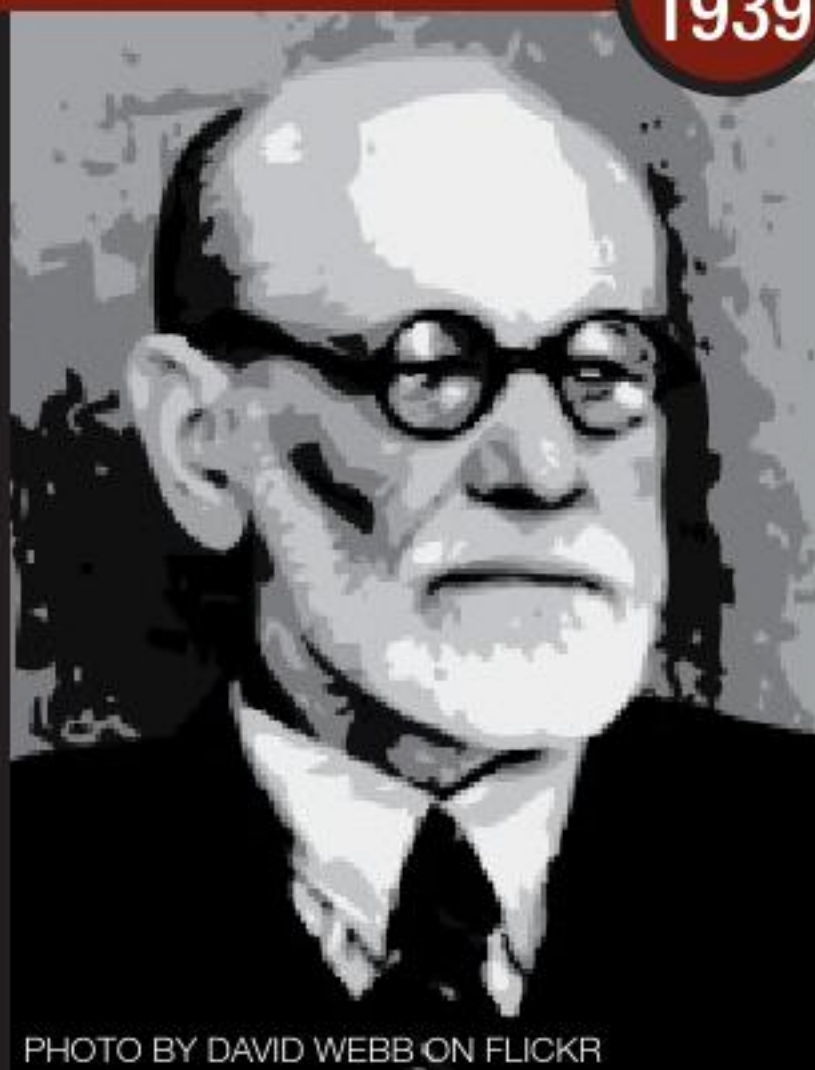


PHOTO BY DAVID WEBB ON FLICKR

EINSTEIN: SCHISM AMONG SCIENTISTS

1879-1955

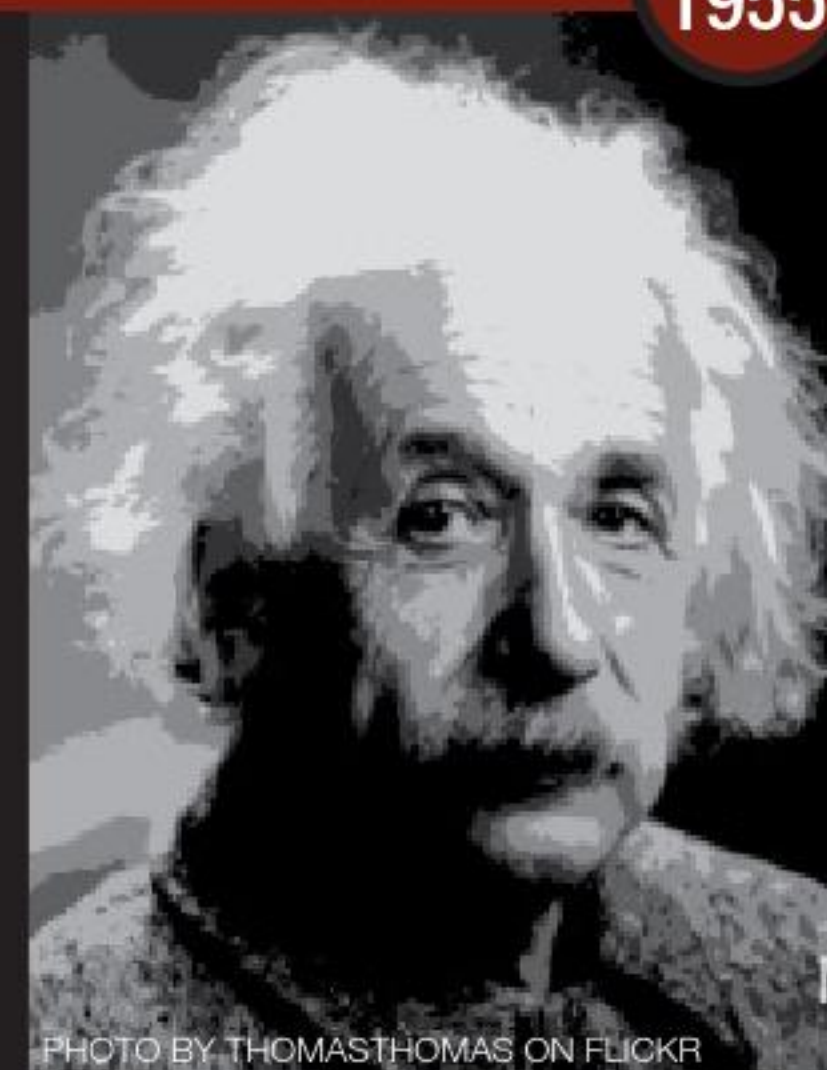


PHOTO BY THOMASTHOMAS ON FLICKR

Swallowed By The Sea

BY CAYMAN SOMERVILLE, ENVIRONMENTAL SCIENCE, 2017

Venice, Italy—a city known for its undeniable beauty, extraordinary architecture and art—may one day be no more. The World Heritage Site is one of many cultural treasures losing the battle with rising sea levels. Yet the voices of countries at risk to rising sea levels are often not loud enough to strike the world's leaders, who are nonetheless the heads of nations most responsible for this climate catastrophe.

The former Prime Minister of Tuvalu, Saufatu Sopoanga, addressed the United Nations General Assembly in 2003 to express his concern for the island nation, one of many low-lying places most vulnerable to the effects of global warming. In his speech he stated: "We live in constant fear of the adverse impacts of climate change. For a coral atoll nation, sea level rise and more severe weather events loom as a growing threat to our entire population. The threat is real and serious, and is of no difference to a slow and insidious form of terrorism against us."

More than ten years later, sea level rise is even higher and increasingly an irreparable effect of anthropogenic warming. In 2003, the Intergovernmental Panel on Climate Change (IPCC) forecasted projections of future sea level rises in their Fourth Report, claiming that both warming and sea level rise would continue for centuries "due to the timescales associated with climate processes and feedbacks," even if we cut greenhouse gas (GHG) emissions to zero. As portions of the Fifth Report have begun to be leaked, it has become clear that the IPCC's early predictions were vastly underestimated, and that coastal cities and low-lying nations are more vulnerable today rather than in a few decades. A special report on managing the risks of extreme weather and natural disasters, released by the IPCC in 2012, indicated that it was "very likely" the mean sea level rise would contribute to "upwards trends in extreme sea levels in the future."

The latest IPCC Report projected the sea level to rise by up to 98 cm by 2100, with variations of 28 to 98 cm (0.92 to 3.2 ft) due to regional deviations and local factors. In fact, these disparities indicate that the local sea level

rise can be higher than the projected estimate for the global mean sea level rise. While these projections are higher than in previous IPCC reports, experts have expressed concern over underestimates by the IPCC, having detrimental implications for low-lying states and coastal cities most at risk.

"Melting ice caps result in an increased amount of freshwater in the ocean, threatening the delicate marine ecosystem surrounding the islands..."

But what do these serious implications look like? The Maldives, a nation with a population of 335,000 people on 1,200 islands, are merely 1.3 meters (4.3 feet) above sea level. The Maldives are arguably the country most threatened by human-caused sea level rise. A rise of a mere three feet would completely submerge the Maldives, rendering them uninhabitable. As the sea level has been projected to rise at most 3.2 feet, with speculation that this increase may be larger and unavoidable due to feedback mechanisms, this future doesn't seem too far away. The entire population of the Maldives will one day join a body of climate refugees—individuals displaced by climatically induced environmental disasters.

Even if this foreseen doomsday for areas most at risk will occur in the distant future, the economy and marine environment of the Maldives are already being affected by the melting of polar ice caps and the sequent sea level rises. According to the National Geographic, tourism and fishing industries are first and second, respectively, in regards to the nation's largest industries. Many of the islands have been developed as tourist resorts, supporting more than 25 percent of the economy. As they continue to slowly sink underwater, the islands can support fewer tourists and less tourism infrastructure.

Melting ice caps result in an increased amount of freshwater in the ocean, threatening the delicate marine ecosystem surrounding the

islands, which has adapted to very salty water. Increased dissolved carbon in the oceans have caused changes in seawater chemistry, known as ocean acidification, causing irreparable damage to coral reefs. These fragile habitats also may not be able to support as many fish, causing fisheries to suffer. As a majority of locals holds jobs that support these two industries, without these incomes, many Maldivians will be forced to emigrate in order to find a new livelihood.

As it seems these realities are unavoidable, the question is no longer how this future could be prevented, but where these climate refugees will end up and who will be responsible to take action. While leaders of countries at risk, like the Maldives, have begun to plan an evacuation program, it is projected that at some 200 million more people will be considered climate refugees by the year 2050. Clearly, there are humanitarian concerns accompanying these predictions. The International Organization for Migration considers the issue of climate refugees to be both problematic and controversial: "Problematic because it has no legal standing under existing international refugee and asylum law, and controversial because there is little agreement as to what to do about the problems it presents." Environmental refugees, falling through the cracks of asylum law, will be forced to flee severe flooding and may find themselves with nowhere to go.

While global leaders have begun to recognize that mitigation is critical, the United Nations Framework Convention on Climate Change has called for an interdisciplinary approach, consisting of measures "to enhance understanding, coordination and cooperation with regard to climate change induced displacement, migration and planned relocation, where appropriate, at national, regional and international levels." Global climate change is not only an environmental concern, but also an ethical, economic, and societal concern, which will call for difficult decisions to be made by world leaders. ■

Let Me Ascophyll You In

BY SHANNON JONES, MARINE BIOLOGY, 2016 AND KATIE HUDSON, MARINE BIOLOGY, 2017

To beach managers and beachgoers alike, seaweed is a nuisance. Beach managers and town governments in places like Nahant, Massachusetts are often given the task of spending a large portion of their budgets on the removal of washed-up seaweed in an attempt to make the beaches more aesthetically pleasing. Beachgoers often complain about seaweed, not only when it washes up on the beach and begins to decay, but also when it floats in the surf zone.

Travel further up the East Coast to Maine, and the brown seaweed species collectively known as rockweed becomes much more abundant and increases in value. Rockweed harvesting has become an increasingly popular industry in the past 10 years as a result of fishery decline, although it has been a common practice since colonial times. The rockweed is harvested either manually with rakes or mechanically and hauled back to the docks in boats. From there, it is either sold raw or dried and processed. Raw, the seaweed was only worth three cents per pound in 2011. The processed rockweed, however, in its variety of forms, including food supplements, fertilizers, and animal feed, is worth upwards of \$20 million, making it one of Maine's most valuable resources.

Regulation

This industry has not gone unnoticed by our neighbors to the North. In recent years, rockweed harvesters from Canada have migrated south into Maine to take advantage of this valuable resource. As a result of this and local harvests equaling 15.3 million pounds in 2011, the Maine Department of Marine Resources began to regulate rockweed harvesting. The department now requires all harvesters to have a permit from the state to harvest rockweed from public land. In most states, the intertidal zone where the rockweed is found is considered to be public land. However, in Massachusetts and Maine, landowners own the intertidal zone on their property. Complications arise from the fact that the privately owned intertidal zones may also be used for fishing and navigation.

Depending on whom you ask, rockweed harvesting may be considered fishing. It also doesn't help that the Maine Supreme Court has been defining this law on a case-by-case basis.

Offshore, which is defined as the area below the low tide line and seaward, harvesting is permitted with a permit by the state of Maine. Some believe this practice is no longer sustainable due to the increased harvest of rockweed, even with the permit system. Several pieces of legislation have been proposed in the past decade, including one that protected Cobscook Bay in Lubec, Maine from any harvesting activities and another that was proposed in January 2014.

Logistics

Harvesting rockweed is a difficult task, one that has been executed in various ways over the years. Historically, it has been done with mechanical harvesters, which were effective but damaged much of the plant. This method was acceptable when the product was being used only for sodium alginate and kelp feed, but harvesting by hand or with long bladed rakes has recently become predominant. As of today, there are no mechanical harvesters used in Canada. Thus, allowing Canadian companies to harvest in Maine would create many jobs, which is a selling point in the modern economy.

Canada's stated goals in *Ascophyllum* harvesting are to maximize employment, remain sustainable and environmentally friendly, promote the industry, and integrate *Ascophyllum* harvest with other marine resources. However, Maine residents are unsure if this is truly what they will get from the deal – they remain dubious about the effect on the natural environment. Part of this concern sprouts from the repeal of the acts protecting the intertidal habitats that will occur if legislation is passed to allow Canadian companies to harvest in Maine. These opponents of Canadian rockweed harvest have the opinion that since *Ascophyllum* serves as a vital home for many organisms in the intertidal zone, removing

it will have a negative effect on the area, which is among the most diverse areas of Maine, providing vital feeding and breeding grounds for multiple endangered snails, fish, birds, and whales. There are conservationists who are working to combat the Canadian harvest, and rockweed harvesting as a whole, by enacting a moratorium on fishing and harvesting in Cobscook Bay. This would suspend all activity in the area to preserve diversity for an undefined period of time.

Benefits

Others in the area do consider the harvest to be a positive thing, and are opposed to the regulations that are already in place. As of right now, 54 percent of the bay is off limits, and American companies who harvest rockweed in the area are not amused. "All seaweed below high water is in the public trust," claims Robert Morse, owner of the company North American Kelp, which operates in the area. This claim is based off a law passed in 1647, which, interestingly, states that, *"in all creeks, coves and other places, about and upon Saltwater, where the Sea ebbs and flows, the Proprietor of the land adjoining, shall have proprietie to the low water mark.... Such proprietor shall not by this libertie have power to stop or hinder the passage of boats or other vessels in, or through any Sea, creeks, or coves, to other men's houses or lands."* It seems this law has not been altered or rescinded since the formation of the country, which would make the rockweed public property, meaning it can be harvested by anyone in the area.

While these issues do not affect us in Boston directly, the stances taken by the government and policymakers could influence more local policies in the near future. ■

FOR STRUGGLING POLAR BEARS, GOOSE EGG(S)

BY CLAUDIA GEIB, JOURNALISM AND ENVIRONMENTAL SCIENCE, 2015

Polar bears on Canada's Churchill peninsula may have found an unlikely ally in their struggle against climate change: a migratory white bird called the snow goose.

Each summer, the melt of sea ice in Arctic regions drives polar bears from their normal habitat and onto land. Around the tiny town of Churchill, set on a peninsula of the same name jutting into the western Hudson Bay, bears wander the empty tundra and occasionally stroll past the borders of the town itself, providing ample opportunity for visitors to observe the bears face-to-face. Churchill has become the center of a tourism trade based entirely around one species, and the window through which scientists and tourists observe the plight of the polar bear.

While relocation to land during the summer has always been part of polar bears' lives, over the past few decades, global climate change has decreased the time over which sea ice covers Arctic waters like the Hudson Bay. This has left bears with a smaller window to hunt seals, their natural prey, and a longer time onshore with little to eat. Yet on the Churchill peninsula, the lengthened summer also means that polar bears now lumber onshore at the peak of snow goose breeding season, finding themselves in the middle of a veritable avian buffet.

“POLAR BEARS HAVE ALWAYS BEEN OPPORTUNISTIC FEEDERS, AND HAVE BEEN OBSERVED EATING EVERYTHING FROM WHALE CARCASSES TO HUMAN TRASH”

Churchill has long been a stopover point for snow geese, which migrate north in the summer months. Recently, human development of old habitats, such as marshes, in southern regions has driven geese to the peninsula in larger and larger numbers. Breeding pairs of the species Churchill peninsula have jumped from 2,500 pairs in 1969 to 75,000 today. The arrival of more and more snow geese has been accompanied by disastrous results for the Churchill tundra, with

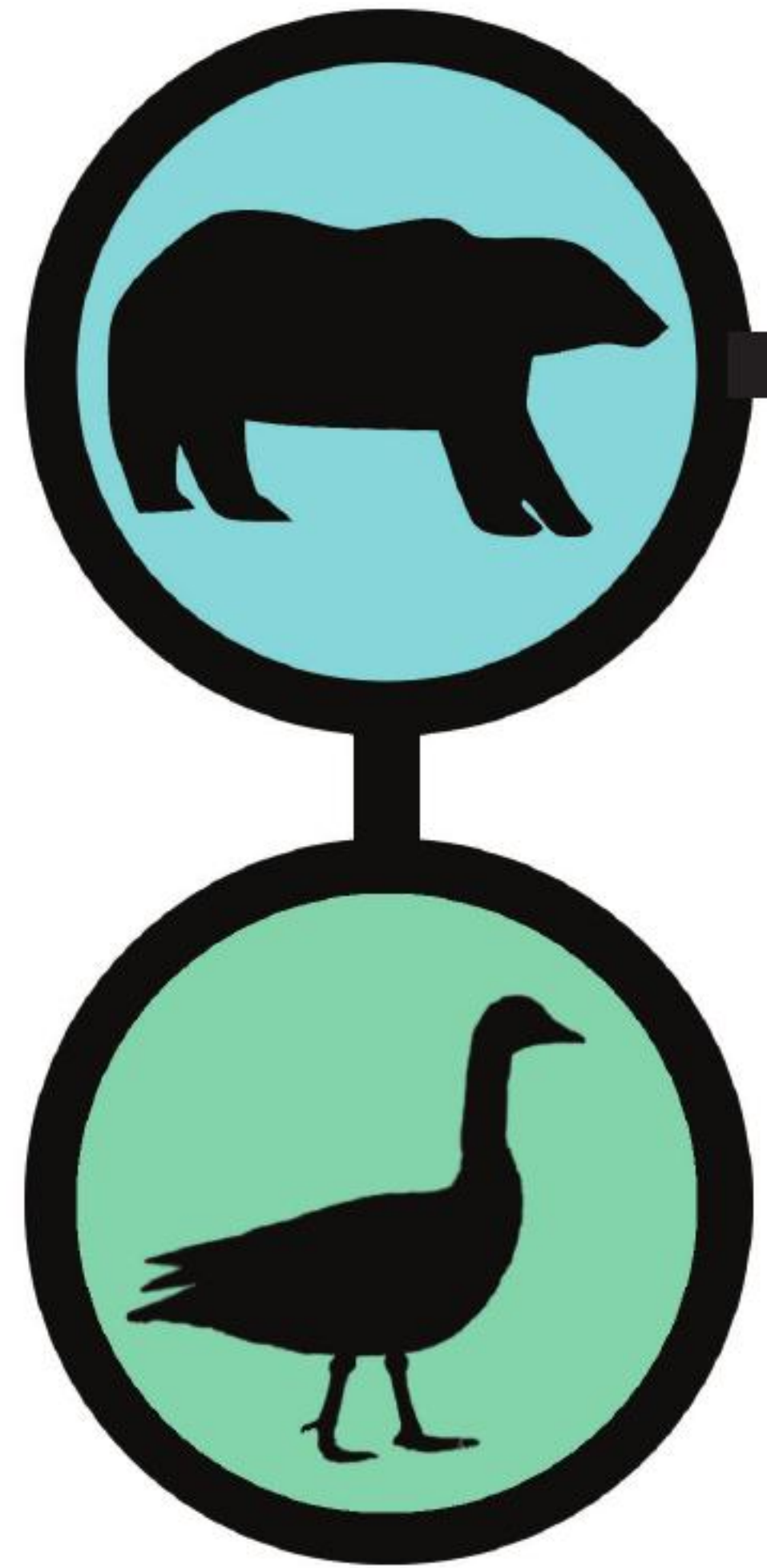
hungry birds eating and trampling huge patches of grass into mud.

Bears have been observed both hunting these marauding birds themselves and raiding their nests for eggs, a behavior which has also been observed in cranes, eagles, foxes, and wolves. Studies of polar bear scat have found that the bears consume much higher amounts of goose, goose eggs, berries, and caribou today than they did in years past, supplementing the fat stores gained from winter seal hunts with terrestrial food to survive the warming summers.

It has been suggested that the addition of snow geese to the polar bear's summer diet may both provide a boon to hungry bears and help slow the damage done by geese to the tundra ecosystem. However, scientists are quick to tamp down any assumptions about the impacts of this dietary change. The current population of snow geese need only produce two successful offspring throughout their life for today's numbers to remain constant, yet geese commonly produce four to five eggs over the five or six breeding seasons they enjoy in a lifetime. Even with predation from bears and their fellow carnivores, snow geese numbers will likely continue to increase, albeit at a slightly slower rate than previous years.

This new food source also does not point towards salvation for the famous Arctic bears. Polar bears have always been opportunistic feeders, and have been observed eating everything from whale carcasses to human garbage. The growth of snow goose populations in the bears' territory has provided a fortuitous opportunity for these hunters, but there is as of yet no evidence that geese and other terrestrial foods could provide the calories necessary to sustain current populations.

The biggest concern for polar bears today remains whether Arctic sea ice will one day become so scarce that polar bears will no longer be able to hunt upon it. Blubber-rich seals still comprise the largest part of the polar bear diet, and are therefore most essential to the species' survival; but bears need floating ice in order to catch seals, and have little success at capturing their prey in open water.



Meanwhile, sea ice melt has so far evaded all attempts at prediction. Current rates forecast that the Arctic will be ice-free in somewhere between 20 and 30 years. However, various models both push this deadline further and pull it closer depending on natural processes. September of this year saw Arctic sea ice at its sixth lowest level observed.

Like the ice that supports them, polar bear populations will continue to remain in flux over the next few decades. The World Wildlife Fund currently predicts that there are approximately 20-25,000 bears remaining worldwide, and they reported that as of 2013, 5 of 19 polar bear populations were in decline. Yet if the example set in Churchill provides any lesson, it is that the polar bear and similar species threatened by climate change will continue to push the limits of ingenuity in order to survive. ■

BEYOND DOLLY

BY KAYLA GOMES, PHYSICAL THERAPY, 2017

Cloning, once bound to the pages of *Brave New World*, was brought into reality in 1996 with the birth of a lamb named Dolly. Scientist Ian Wilmut and his team inserted the nucleus from an udder cell belonging to one ewe into a hollowed-out egg cell from another ewe. Once fused, this single cell was allowed to grow and then placed in a surrogate mother who gave birth to the first mammalian clone derived from an adult cell. This new discovery allowed the scientists to create a clone from an already-specified adult cell, rather than embryonic stem cells that are unspecified, was huge.

This breakthrough raised many questions in the scientific and political communities as to how far cloning should go. Human cloning of any kind was too complicated a task to be possible in 1996, but science was advancing quickly. After the creation of Dolly, many speculated cloning from human cells was around the corner.

In 1997, President Clinton raised a memorandum questioning the ethics and safety surrounding human cloning despite its potential in areas such as medicine. This memorandum led to the FDA banning research where the end result would be the creation of a viable human via cloning. In addition, the Federation of American Societies for Experimental Biology and other professional organizations, representing more than 67,000 scientists, issued a voluntary moratorium against human cloning.

Despite these bans, the scientific community felt the loss of what cloning from human cells had to offer. Today, some replication of human cells through cloning is permitted, but strictly towards biomedical research and not the production of humans. This remains a hotly disputed topic today, especially with the promising outlook on cloned embryonic stem cells for the treatment of diseases such as cancer. When it comes to human cloning, there will always be the fine line

to cross between advancing society and pushing ethical and moral boundaries.

In contrast, there is not nearly as much ethical dilemma with cloning other animal species. Scientists have already asked, "Why stop at Dolly?" The inner child in us all would love to see woolly mammoths and dodo birds walk the Earth again, but how, and at what cost?

To clone an extinct species back into reality, scientists collect various amounts of DNA from the extinct animal's remains. These pieces are brought together to recreate the animal's genetic sequence as much as possible. The problem? When extracting a DNA sample from the extinct animal there is contamination of DNA from other species that co-existed with it, such as bacteria or fungi. Even DNA extracted from complete bodies of woolly mammoths that are wonderfully preserved in permafrost belongs, at most, to 50 percent of that mammoth. In comparison, DNA harvested from a woolly's fossilized tooth is about three to ten percent mammoth. Though there are various means to decontaminate the sample, there are holes in the genetic sequence caused by the deterioration of DNA over time. To remediate this issue, this Swiss cheese DNA is then fused with DNA of an existing organism with a similar genetic sequence, like the woolly mammoth and the Asian elephant. These clones and their subsequent offspring would breed and over time an animal very, very genetically similar to a woolly mammoth would exist, a "clone." This is a time-consuming, expensive process.

So why bring back these species? One idea is to restore habitats to their previous splendor with the influence of animals that once lived there. For example, scientists in Europe are attempting to bring back aurochs, large cattle that grazed the countryside, to replace the domesticated cattle of today. These scientists argue that the "ecological richness" the aurochs

can bring to existing ecosystems may provide better balance than humans can. The majority of ecosystems that extinct animals once belonged to, but which no longer exist. However, a change in ecosystem may very well have caused the animal to go extinct in the first place. Which begs another question: where would these resurrected animals even go? Zoos? Would we throw them in an updated ecosystem and hope for the best? Even if scientists could clone or breed a large number of an extinct species, the lack of genetic diversity would not allow the species to survive for very long.

Perhaps a better alternative for these resources would be perfecting the same cloning technology used with extinct species to strengthen the conservation efforts of endangered species today. If a single faulty gene is causing the demise of an endangered animal, scientists could clone a generation without that faulty gene to be released in the wild. Through natural selection, that species would eventually be void of that gene.

It is difficult not to be critical of this topic due to the sheer time, energy, and resources required. It all comes down to how involved humans want to be in the natural universe. Humans have contributed to the demise of many species. So how do we decide between bringing back a species we may have destroyed and saving an endangered species today? Cloning humans or animals is a power that some would say is playing God, a power that can contribute greatly to our understanding of biological science and unlock unlimited possibilities in the future. However, the science isn't perfect. The success rate of any type of cloning is still unbelievably low. This low success rate gives scientists pause to really think about what they're attempting to achieve. The fantasies are real and we've seen positive results; but to avoid a real-life *Jurassic Park*, humans need to proceed with caution. ■

1885



IDENTICAL SEA URCHINS
CREATED IN LAB BY
EMBRYO SPLITTING

1952



FIRST NUCLEAR
TRANSFER IN TADPOLE

1996



DOLLY IS THE FIRST
CLONED MAMMAL

1997



FIRST CLONED PRIMATE

2013



EMBRYONIC STEM
CELLS CREATED VIA
NUCLEAR TRANSFER

EXTENSION OF MAN: THE TROUBLING TALE OF WEARABLE TECH

BY OLOLADE AKINGBADE, BEHAVIORAL NEUROSCIENCE, 2017



Photo Courtesy of Google Glass

In an age of computerization and digital accessibility, innovation is synonymous with an extension of technology to unexplored platforms that maximize convenience and functionality. A rapidly expanding and unduly fascinating frontier of advancement is that of wearable technology. Wearable technologies, or simply "wearables," look to converge elements of fashion, aesthetics, design, and function with digital advances. It's a trend that dates back to rudimentary calculator watches and fashionable Bluetooth headsets, which has now expanded to modern devices like smart watches, integrated fitness monitors, and smart glasses. While smart watches and fitness monitors emphasize the aesthetical functionality of wearable tech, smart glass technology targets the ubiquitous integration of technology with lifestyle. Google positioned itself on the forefront of the wearable tech wave with its prototype device Google Glass, head mounted eyewear that provides computer accessibility through hands-free commands.

From an efficiency standpoint, Google Glass makes life simpler. Calendar dates, reminders, weather, messaging, travel alerts, maps, and photos are all integrated into the line of sight, which allows for hands-free management of daily duties and seamless connection to the outward world and the Internet. The photographic aspect of the device is one of its most striking. Users can take discrete pictures of their surroundings, places and people included, a function that underscores privacy concerns.

Google Glass offers new opportunities for seeing and living for people with disabilities. Through Google Glass's Developers program in which selected individuals report its efficiency, the technology has been piloted in groups with hearing impairment, as well as cognition and movement disorders such as cerebral palsy.

Mark Perriello, president and CEO of the American Association for People with Disabilities says that "Google Glass has a ton of potential to transform lives for people with disabilities. Not everyone has had the good fortune to experience Google Glass at this point. But for those who have, the technology features a number of things that make it really user-friendly for people with disabilities -- voice-activated technology, the potential for speech-to-text, face recognition

-- all of which can help people with a variety of disabilities." According to Perriello, Google Glass could have a transformative effect on how people with disabilities function in society.

Although Glass has been largely successful among a selected crowd of web developers and public beta testers, it has gained limited traction from the public with its May 2014 release and 900,000 units sold to date. As a device that is still very much in its development stage, the measure of Google Glass's success is less defined by its profit and more by its application and influence on the future of wearable technology. It's an example of the larger implications of wearables: convergence of computing with everyday life.

"GOOGLE GLASS COULD HAVE A TRANSFORMATIVE EFFECT ON HOW PEOPLE WITH DISABILITIES FUNCTION IN SOCIETY"

Questions both fascinating and fearful arise with this model of wearable tech as a primer for technological ubiquity and the merging of digital advances with daily life. Wearables have the power to alter human behavior since with wearable technology, access to information is constant, instant, and omnipresent. Specifically, wearables have potential implications for social motivation and goal reinforcement. Michael Davies, a digital strategy consultant and Senior Lecturer at Massachusetts Institute of Technology, notes in a tech paper that "sustained engagement with a wearable device or complementary service depends on its ability to help the user form and stick with new habits... The best wearable devices have the potential to make the process of habit formation more effective and efficient than ever before."

Wearables also have the potential to become addictive. With the continued computerization of society, Internet addiction, formally coined as Internet Addiction Disorder (IAD), is defined by Cornell psychiatric researchers as being "characterized by excessive or poorly controlled preoccupations, urges, or behaviors regarding Internet use that lead to impairment or distress." IAD's classification as an addictive psychological disorder continues to be debated

by the American Psychiatric Association; many psychiatrists argue that though the disorder has psychological implications, it does not limit an individual's quality of daily functioning. The gravity of this tech-era disorder was most recently seen in a Navy Serviceman who developed an addiction to Google Glass.

The 31-year-old man had a long history of mood and depressive disorders related to a past history of alcohol and drug abuse, as outlined in the research literature release by the Naval Substance Abuse Recovery Program in San Diego. After wearing the device for 18 hours a day for two months, researchers noted that "if he had been prevented from wearing the device while at work, he would become extremely irritable and argumentative. The man experienced withdrawal symptoms that he reportedly said were much worse than the withdrawal he went through from alcohol." Considering the confounding variables that influenced this man's Google Glass addiction, it's clear that there is still a lot of research to be done on the psychological influence of wearables and how they alter our behaviors, sometimes for the worst.

Will wearables serve as the fast track to a sci-fi-esque, trans-human society? Considering the limited public support for wearable tech, perhaps not. Close to 72 percent of Americans reject Google Glass on privacy issues alone. Even so, wearable technology foreshadows a striking paradigm for the exponential model of technological growth: an existence where our senses serve as the interface for technology, and computer systems and mental pathways become inseparable. Are humans on the verge of blurring the lines between people and machines? The tangible human value of these devices must be assessed before we aid in the establishment of a wearables-addicted generation. ■

SMOKE THIS, NOT THAT

BY JOSHUA TIMMONS, BIOLOGY, 2016



The term 'e-cig' represents the end of an era. In some ways, it was inevitable—grounded tobacco and filter papers seem antiquated, since Native Americans were smoking those centuries before Columbus called them by the wrong name. In this century, e-cigs may represent a healthier alternative to smoking.

E-cigarettes are battery-powered devices that heat aerosolized nicotine in a solution of glycerol that the user then inhales. Their new absorption method and steel bodies lack the stigma of their 'coffin nail' ancestors. Blu eCIG, for example, uses triumphant verbiage, like "Rise from the Ashes," to purport its guilt-free smoking experience. Actor Stephen Dorff says in one Blu ad, "I'm tired of feeling guilty every time I want to light up."

The C-rate actor may be onto something: the only clinical trial to date was unable to find any adverse health effects. E-cig mist ('vapor' is a misnomer) has fewer toxicants than combustion cigarette smoke. Furthermore, these trials found the possible carcinogens anabasine, myosmine, and nicotine are at a thousand time weaker concentration than in conventional cigarettes. Thanks to this reduction in toxins, smokers can now get their nicotine without feeling like they're harming themselves and everyone around them.

The assumed health benefits of using e-cigs, and the lack of social judgment, are contributing in equal part to a meteoric rise in e-cig use. E-cigarettes were Goldman Sachs' number one disruptive trend of 2013; they predict e-cigs will make up 15 percent of all tobacco profits by 2020. Presently, Americans are predicted to spend \$2.2 billion on e-cigs in 2014. It's a start, but still peanuts relative to combustion tobacco's \$85 billion in yearly sales.

In spite of all this, e-cigs have been ostracized by health officials. It has been three years since

Boston instituted a ban on e-cig smoking in places where conventional cigarettes are banned, and there have been no talks of lifting it. Additionally, in April 2014, the Food and Drug Administration decided to regulate e-cigarettes in a similar manner as cigarettes. Minors are now prohibited, ingredients must be reported before approval, and health claims must be substantiated by evidence—despite the lack of current research.

"SMOKERS CAN NOW GET THEIR NICOTINE WITHOUT FEELING LIKE THEY'RE HARMING THEMSELVES AND EVERYONE AROUND THEM."

Most efforts to curb e-cig promotion have been due to the perceived risk of creating new smokers. "Over the last 50 years, 20 million Americans died because of tobacco. We are fiercely committed to preventing the tobacco industry from addicting another generation of smokers," says Nancy Brown, CEO of the American Heart Association. Public health advocates have criticized such claims as a moralistic reflex.

Contrary to these arguments, e-cigs may actually help current smokers stop smoking. One recent study demonstrated that e-cig use, when done for the purpose of quitting smoking, was comparable to existing nicotine replacement therapies.

The more progressive stance in the public discussion is one of harm-reduction. In a NEJM review, Nathan K. Cobb, M.D., and David B. Abrams, Ph.D. make the case for e-cigs as a useful tool: "Their use could shift smokers permanently away from lethal cigarettes to cleaner, safer nicotine products, saving innumerable lives."

Acknowledging the poor health outcomes that come from cigarettes, Dr. Joseph Kannam, a cardiologist at Beth Israel Deaconess Medical Center and associate professor of medicine at Harvard Medical School, says, "ideally, we get all these patients using tobacco and get them to e-cigs, and then off e-cigs." While he's never been in a situation to recommend e-cigs, he says it's not out of the question: "I can see doing it, if it comes up."

Kannam agrees with the ban on public advertisement, noting the harm that could come from widespread advertisement. "I'm afraid of it on TV— it will get marketed to new people the same way chewing tobacco was."

"Primary physicians or health professionals should be the ones to help get people off tobacco," Kannam claims, stressing the importance of physician intervention.

True widespread acceptance of e-cigs will depend on researchers' ability to demonstrate that e-cigs have conclusively better outcomes, in addition to the willingness of smokers to try a new form of inhalation. While the ultimate goal may be total eradication of smoking, it remains to be seen if e-cigs will help in that pursuit. Whether e-cigs represent the end of a century-long addiction to tobacco, or simply a new phase in nicotine dependence, will be seen in years to come. ■

THE CURIOUS CASE OF PABLO'S HIPPOS

BY ANDREW BLOY, BIOLOGY, 2017



Down the murky Magdalena River, deep in the wilds of Colombia, there is a growing problem. It began in 2007, when fisherman in rural Colombia reported a bizarre animal with small ears and a gigantic mouth. This animal turned out to be a large African land mammal - the hippopotamus. While hippos are one of the world's most recognizable animals, that recognition fades when they are found well over 4,000 miles away from the rivers of Africa, their natural habitat. So, how did these three-ton animals move from Africa to Colombia? One word: *cocaine*.

It all started in 1975 when a petty criminal named Pablo Escobar began his rise to power and notoriety when he founded the infamous Medellin Cartel. At the peak of his power, the Medellin Cartel was earning \$60 million in revenues every day, mostly due to the fact that they controlled 80 percent of the global cocaine trade. With about three billion dollars in personal wealth to play with, Escobar spent extravagantly on sprawling, extravagant estates, building schools and hospitals, and financing local soccer teams. This is where the hippos come into play.

Escobar's estate, the Hacienda Nápoles, featured a large zoo that Escobar maintained and kept open to the public. Giraffes, ostriches, elephants, bison, antelopes, zebras, and of course, hippopotamuses. When Pablo Escobar died in 1993, the Colombian government seized his estate. Without a steady flow of drug money, the zoo's new owners were unable to handle the costs of running the zoo. The Colombian government went about shipping the animals to zoos in Colombia and worldwide. The animals that were valuable or easy to ship were swiftly dealt with. However, there was one group of animals that no zoo showed any interest in: Escobar's four hippos. Without any other option, the Colombian government left these hippos to fend for themselves inside the neglected ruins of the Hacienda Nápoles.

Years passed, and the four hippos escaped the ruins of the Hacienda Nápoles Zoo into the nearby Magdalena River. Soon four hippos became ten, ten became twenty and quickly, there were over fifty hippos in the Magdalena River. The speed at which these hippos multiplied classifies them as an invasive species.

An invasive species is generally defined as a species that has been moved into a location that it is not native to where it can thrive, reproduce and cause damage to the local environment. One of the factors that keeps hippo populations under control in their native Africa is routine droughts. Without droughts, hippo populations can diffuse into new habitats and expand without any factors to slow them. Hippos breed nearly constantly in the shallow, murky waters, and eat constantly from the lush surrounding landscape. These conditions may be perfect for hippos, but their presence is a direct threat to endangered manatees, three species of endangered turtle, endangered crocodiles, numerous endangered fish and bird species as well as a great ape species known as humans.

In Africa, hippos are known as very dangerous animals, killing more people every year than lions, crocodiles, or black mambas. However, in Colombia, hippos are viewed as cute and cuddly, which is where the danger lies. There have been multiple accounts of the local Colombians

capturing the hippo calves and keeping them as pets. Hippos have also been known to destroy fields of crops and attack farmer's livestock. Hippos can be very territorial, and this behavior is only going to increase as time goes on and clashes between farmers and the animals become more frequent.

“IN AFRICA, HIPPOS ARE KNOWN AS VERY DANGEROUS ANIMALS, KILLING MORE PEOPLE EVERY YEAR THAN LIONS, CROCODILES OR BLACK MAMBAS.”

Colombia's hippos present a huge safety risk for local farmers, but also an ecological problem for the river's indigenous species. There are a few ways to deal with the problem of Colombia's hippos but they are not without their drawbacks. The ideal solution is to capture all the hippos, and ship them off to zoos all around the world. However, capturing and shipping hippos is difficult and expensive, and there are not enough zoos and hippo preserves in the world to house Colombia's hippo population. Relocating these animals to the wilds of Africa is also not an option, because the animals may carry location-specific diseases that could have catastrophic effects on wild animal populations across the region they are transplanted to.

Another option is exterminating all of the male hippos to cut the growth of the hippo population. Without males, the female hippos will be unable to reproduce, and will die out over time. The controversy stems from the hippo's conservation status - "vulnerable to extinction." The ethics of killing a vulnerable species, even one that is out of its own habitat and is causing damage to its current habitat, would be bad for public relations and could cause backlash from animal activist groups.

Yet another option is castrating the hippos. That way, no hippos have to die, and no new hippos can be born. However, getting close enough to a 3,500 pound beast with a reputation for killing humans all in murky, muddy water is nearly an impossible task.

The situation regarding Colombia's hippos is as unclear as the waters of the Magdalena River itself. Cloudy, unclear and uncertain, the future of Colombia's hippos largely depends on the Colombian government's ability to act quickly and decisively, before the situation escalates further. ■

"Hippo Closeup" courtesy of Art. G on Flickr

SHOULD HUMANS GO TO MARS?

BY GWEN SCHANKER, BIOLOGY AND JOURNALISM, 2017

When Neil Armstrong became the first man to walk on the moon in 1969, it was a groundbreaking moment for mankind. Since then, human space exploration has become more desirable and, with the increasingly dangerous implications of climate change, some would say more urgent. Mars, Earth's closest planetary neighbor, has long been considered the next logical destination for space explorers. Sending humans to Mars represents the realization of a dream that started years ago, and as Robert Zubrin, president and founder of The Mars Society, says, would signify "the next great step in humanity's outward migration into space."

The concept of a human mission to Mars has been around since the mid-20th century. In the 1990s, Zubrin and his colleague David Baker proposed an initiative known as Mars Direct. Once astronauts reached the red planet – ideally by 1999 – the idea was to use the Martian atmosphere to produce oxygen, water, and enough rocket propellant for a return trip. A modified version of this mission was adapted by NASA as their "design reference mission," but the plan never came to fruition.

Since then, scientists have mapped the entire human genome, developed 3-D printing technology, and created smartphones that recognize their owner's touch. Still, is there enough advanced technology to transport a crew of humans to Mars?

The answer may come from a private Netherlands company currently developing a human mission to Mars, known as Mars One, founded by entrepreneur Bas Landsdorp and physicist Arno Wielders in 2011. The company's first crew is expected to depart in 2024, after which a new crew will depart every four years. The main difference between Mars Direct and Mars One is that the latter is a one-way journey – the four crewmembers that depart in 2024, and those beyond, are never coming back.

In 2013, the Mars One team invited applicants all over the world to post a one-minute video explaining why they wanted to make the journey to Mars. The organization received some 200,000 applications, and by 2015, 24 winners will be selected to undergo nearly 10 years of training before four are selected to fly out as the first crew.

The applicant pool has been narrowed down to 705 potential astronauts. The next step in the process will be interviews with the selection committee, which will be broadcast as a reality TV show. The funds from which will be used to purchase supplies for the journey.

The candidates vary across all age groups and come from all corners of the world. One candidate, Yari Rodriguez, works at MIT Lincoln Laboratory in Lexington. Though being selected as one of 700 from 200,000 applicants might be seen as a stupendous accomplishment, Rodriguez is very matter-of-fact about the possibility of making the one-way journey. "I look at this as donating my life to science," she said. "It's the adventure and the discovery and showing the world that this is possible."

It helps that Rodriguez has the support of her family and colleagues. "It's surreal to them, I think," she said of her large family. "I do have their support. I wouldn't want to be doing something that would really hurt my family."

Rodriguez, and the rest of the Mars One candidates, believe in the importance of space exploration. "So many things could happen to this planet," she said. "I definitely think we need space exploration and that we need to expand to other planets, and that Mars is the closest and most feasible one right now."

The Mars One crew will not only be pioneers – they'll be construction workers, farmers, and scientists. "Once we're there, there's going to be so many new discoveries," Rodriguez said.

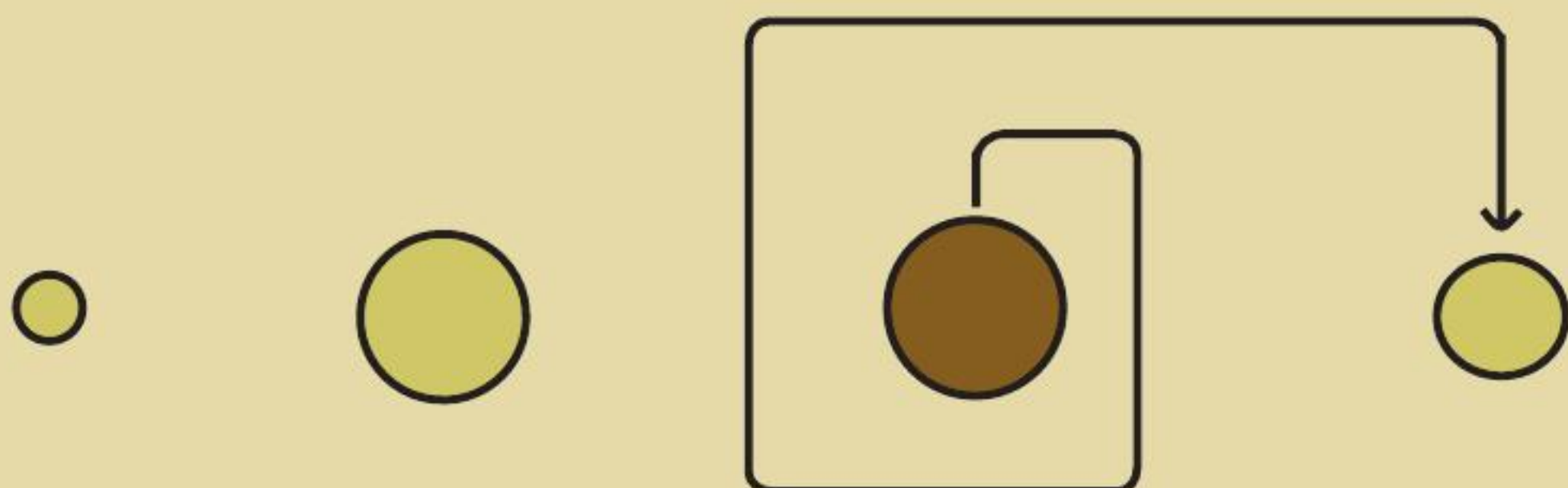
The most prominent concern for scientists is whether those who make the journey to Mars will survive. Although Mars One claims that "no new major developments or inventions are needed to make the Mars One mission plan a reality," a recent study from MIT scientists may tell a different story. The researchers assessed the technical feasibility of the mission and found that mass of the vehicles the team needs to travel to Mars, as well as that of the facilities they will reside in once they get there, is greater than what is currently available. Furthermore, if the group is able to grow enough food to sustain the colony, the crops will produce dangerous oxygen levels, which are not survivable unless some type of oxygen removal system is implemented.

"Based on our findings, [Mars One is] moving at too fast of a pace considering what their objectives are," said Sydney Do, lead author of the study and aeronautics and astronautics Ph.D. student at MIT.

Besides referencing the technical inhibitions to the mission and the lack of testing on how the environment of Mars will impact human physiology, Do mentioned that the one-way trip actually increases expenses rather than reducing them. "One-way missions have a very significant resupply requirement on Earth," he said.

Do and his colleagues are in support of further space exploration, albeit not necessarily in the next 10 years. "It's about that holistic perspective," Do says of the innate human curiosity to expand to other planets, warning that, "ultimately, safety should be at the top of everyone's mind."

Rodriguez dispelled rumors that the mission was doomed to fail. "It's not a suicidal mission like many people say," she said. "We can do this, we're going to do this...I'm hopeful that I will make the next round, but even if I don't, I still want to be supporting this mission." ■



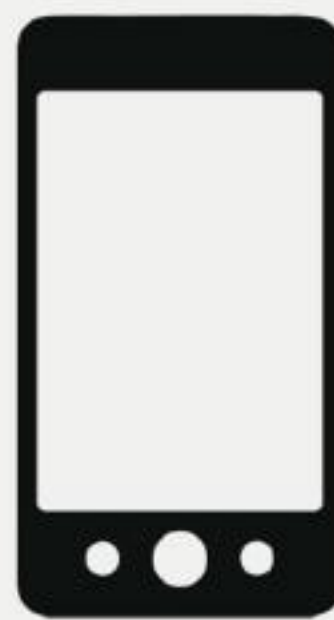
The of Encryption

BY NIGIL LEE, ECE, 2017

In 2013, Edward Snowden showed the world the extent of the United State's domestic spying program. Surveillance programs such as PRISM have created a rift between the tech community and certain three letter organizations. In addition, consumer privacy tech companies are concerned with alienating foreign customers due to the potential of United States government violating their privacy.

Police organizations around the country are finding cell phones to be a wealth of information that some departments can obtain without warrants. Some police organizations assert that the time it takes to obtain a warrant would waste crucial time in their investigative process. Some states, such as California, have had high profile court cases block the police's ability to search cell phone data without a warrant. In response to this, major mobile operating systems are starting to implement full device encryption by default. While all mobile operating systems have had encryption features in earlier versions, they have been mostly tailored for use in a corporate environment. Enabling encryption by default on phones will mean that a much larger proportion of users will have their data protected.

Various government organizations and police departments around the country oppose encryption by default, as it would completely disallow them access to phone data without permission of the owner and allow the owner to irreversibly destroy the data with ease. Chicago Police, Chief of Detectives went so far as to say "Apple [phones] will become the phone of choice for the pedophile" in response to iOS's encryption by default. United States Attorney General Eric Holder has urged the creation of "back doors" for the government and police organizations to use to access data without needing the device encryption key. Technology companies contend that any back door could be exploited by hackers, and that the government's track record is poor when it comes to showing restraint in accessing citizen's data.



There are 328 million mobile phones in the United States



80 percent use outdated and vulnerable technology



This year Apple recieved 4132 government requests for data

Encryption by default only protects data that is stored on the device. All of today's smart phones are backed up by cloud storage services, such as iCloud or Google Services. Recent events such as "Celebgate" and other photo leaks have made it well known that many of these services automatically upload all pictures taken to the cloud. The amount of data people unknowingly upload is larger than this; users, for example, may be surprised to know of the existence of services such as Google Location History. Location History is a service which tracks the movements of Android users for the purposes of applications, such as Google Now, that use the data to enhance user services.

This year is the first year that technology companies have been allowed to report the exact number of requests by governmental agencies. Both Google and Apple have been releasing public transparency reports for several years on the number of government data requests. For both companies, the number of requests has been steadily increasing; Apple received 4132 requests for data from the government in the first half of this year, as compared to something in the range of 1500 last year. These number do not include the number of requests from the secret FISA court, which is used to request large amounts of citizen's data for terrorism related matters.

Such issues are just the beginning of the problem of defining privacy in a digital world. While it may be some time before the issue is settled for good, encryption by default prevents snooping by both malicious agents, both criminal and governmental. These technologies, however, do not prevent the government from accessing any data online, and for full security one should at the very least disable all auto synchronization with cloud services. ■



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